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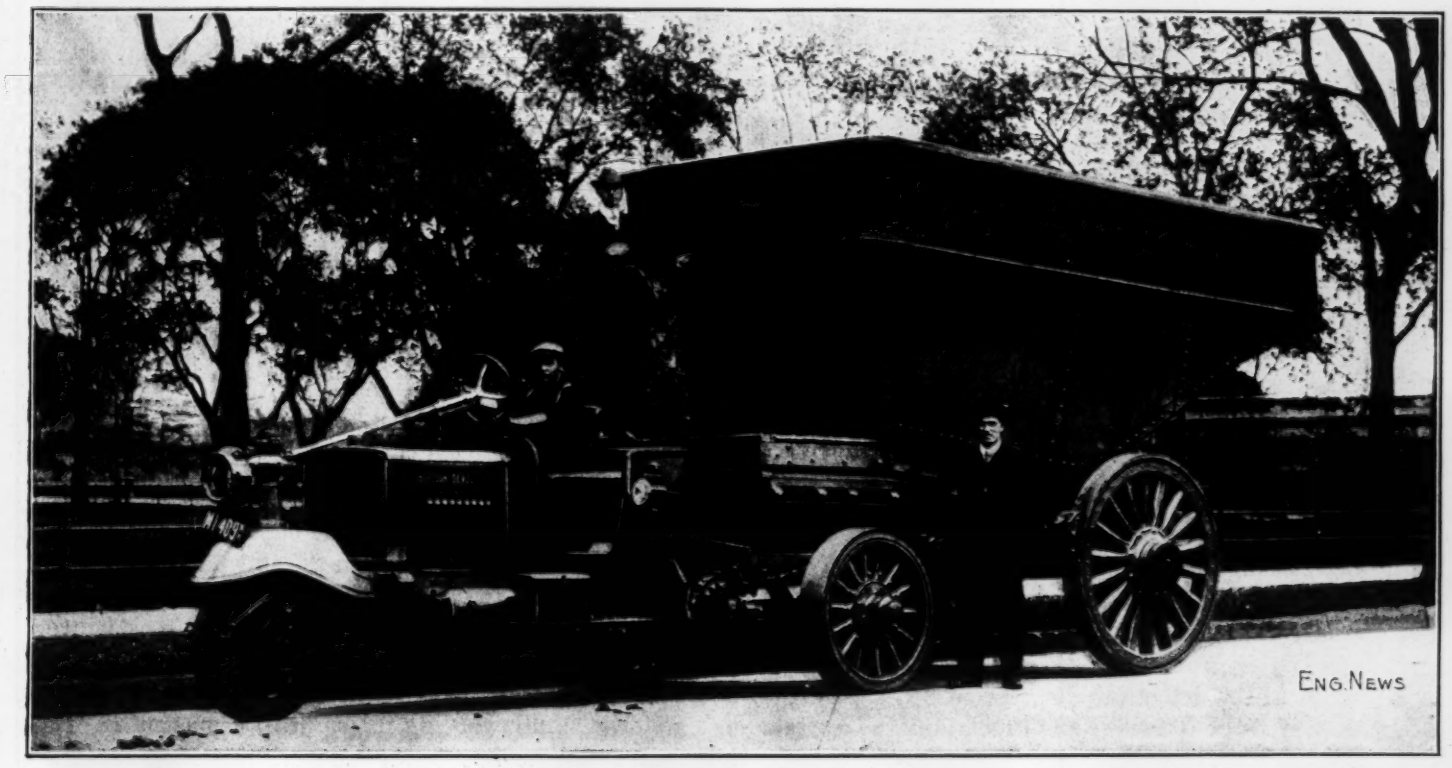
A Very Heavy Motor-drawn Truck

The Borough Development Co., of Brooklyn, N. Y., has recently put into service a very heavy motor-drawn truck, which is used in hauling ashes from various industrial plants, through the streets of Brooklyn to the docks, where the ashes are loaded on barges. A view of this truck is shown in the accompanying halftone. It consists of a steel body of 20 cu.yd. capacity, mounted on a truck provided with rear axles and wheels only, the front portion being provided with a king pin, which fits into the corresponding socket above the rear axle of a specially designed tractor. This tractor is known as the Martin Tractor, and is manufactured by the Knox Automobile Co., of Springfield, Mass.



AN ASH TRUCK OF 20 CU.YD. CAPACITY
(Total weight when loaded with ashes, about 15 tons)

The Martin tractor is a three-wheeled motor device, which may be attached to any two or four-wheeled vehicle and used as the propelling power for that vehicle, the combination making a five- or seven-wheeled truck. With proper provision, of course, the tractor may be used as the locomotive to draw a train of wagons. In some of its uses the body to be drawn is provided with a readily detachable king-pin device, so that the tractor may be run under the wagon, the wagon taken to the place desired, and the tractor then be run out to be used for whatever service required. In one city, for instance, a coal company has employed one tractor with a number of coal-truck bodies in delivering the coal. In this case the truck is drawn to the place where the coal is to be delivered, the tractor run back to the yard for other service, while the coal is being unloaded. In the case of the ash truck shown in the accompanying view, however, at present only one body is in use, and the vehicle acts as a unit. The tractor in question is provided with a 50-hp. motor, a single rubber-tired steering wheel to provide easy maneuvering, and two traction wheels 40 in. in diameter, and fitted each with a 6-in. steel tire. The rear wheels of the truck proper are 54 in. in diameter, and are provided each with a 7-in. steel tire. The tractor is geared down to a speed of 8 mi. per hr. under the maximum load.

As noted above, the truck body has a capacity of 20 cu.yd. Recent measurements in New York City show that the average weight of the ashes there is about 1090 lb. per cu.yd., so that when the truck is fully loaded with average ashes, its weight, exclusive of its own weight, will be about 10½ tons. The distribution of this weight upon the four wheels under the wagon is not given, but from the general appearance of the truck it would seem that the rear two wheels take more than one-half of the total load. If this is so, the load upon each of the 7-in. tires must be in excess of 4 tons. The manufacturer of the tractor states that the truck has carried as high as 15 tons load, though the owner of the truck states that it is not used in practice for loads greater than 10 tons. So far it has been making daily trips on the paved streets of Brooklyn without any damage to the pavements.

Municipal Bridge Approach, St. Louis

By S. W. Bowen*

SYNOPSIS—The Municipal Bridge, "or Free Bridge," now approaching completion, is the fourth bridge to be built across the Mississippi River at St. Louis. It is specially notable, for the great length of its truss span (668 ft.) and for having a double deck, with railway on the lower deck (at the bottom chord level) and highway and electric railway on the upper deck. The article given below describes the viaduct approach for railway and street connections at the St. Louis end of the bridge, together with the methods of construction. Articles by the same author, in our issue of March 16, 1911, and Feb. 8, 1912, have described the substructure and superstructure of the river spans.

The west or city approach to the Municipal Bridge over the Mississippi River at St. Louis, is built to accommodate both railway and highway traffic. The railway deck (which connects with the lower deck of the bridge) carries two tracks. The highway portion (which connects with the upper deck of the bridge) consists of a 30-ft. paved roadway and two 6-ft. sidewalks; in the roadway are two electric-railway tracks. The general plan, Fig. 1, shows that shortly after leaving the river spans, the highway deck swings to the south until it clears the railway deck. The two decks are then carried side by side to Broadway, where they diverge, the highway structure coming to the ground at 7th and Papin Sts., and the railway at 8th and Gratiot Sts. From 8th to 23d Sts. it is proposed to run the railway tracks on the surface of Gratiot St., which lies along the south side of the railway yards in Mill Creek Valley. It is probable that 7th St. will be widened to give a better entrance to the highway approach.

Between 4th St. and Broadway there is a station building, with waiting rooms, etc., and stairways leading to the railway and highway levels. At this point provision has been made for a future 20-ft. roadway, leading to the south and ending at the east side of 4th St. This is intended to accommodate wagon traffic from the southern part of the city if it should be of sufficient volume to warrant the construction of an independent approach. As Mill Creek Valley is the main railway artery of the city, provision has been made for a future connection between the railway structure and these tracks, the connection diverging to the northwest at 7th St.

For the approach, the maximum grade on the highway is 3.443%, while that on the railway is 1.385%. The total length of the approach is about half a mile. The alignment is shown in Fig. 1. The portion of the city through which the approach passes is old and very thickly settled. A right-of-way 100 ft. wide was cut through the blocks to accommodate the structure, which in general has a total width of about 69 ft. At Broadway where the tracks are spread to allow for the station platform, the total width is considerably greater.

The approach consists of a steel superstructure of the plate-girder type, with columns supported on concrete pedestal piers. The roadway is to be paved with creosoted-wood blocks, laid on a reinforced-concrete slab supported on I-beam stringers. The sidewalk slabs will be of reinforced concrete. The railings are of steel. The railway deck will have 90-lb. rails on 8x10-in. creosoted ties.

Foundations and Subsurface Conditions

The distance from ground surface to bedrock varies considerably. At Pier I (the west pier of the bridge), rock lies about 50 ft. below the curb. From this point it rises gradually until between 2d and 3d Sts. its depth is only about 15 ft. It then dips to the west, and at 6th St. is at least 60 ft. below the curb. The rock is overlaid by a stratum of sand of varying thickness and fineness, with streaks of clay. The greater part of the upper material is fill, varying in depth to a maximum of about 15 ft. This fill is made up of earth, bricks, stones and rubbish, and most of it has been in place 50 years or more.

The material down to bedrock was investigated by means of wash borings and as a result it was decided to carry all foundations through the filled ground to the underlying material. Comparative estimates were made of the cost of the following types of foundations: concrete pedestals on reinforced-concrete piles, plain concrete pedestals, plain concrete shafts (or piers) extending to the rock, and concrete pedestals with reinforced-concrete footings. All the concrete pedestals were assumed to extend through the filled material or to about 1 ft. below the bottom of the cellars.

No tests were made of the bearing power of the soil or of the supporting power of the reinforced-concrete piles. But from a careful consideration of the results of the borings, of excavations and pile-driving in the immediate vicinity, and of tests of soil and piles previously made

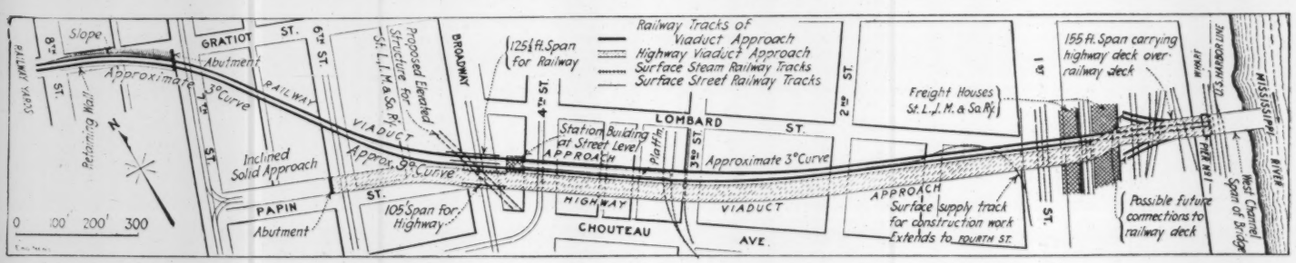


Fig. 1. Plan of West or City Approach to the Municipal Bridge, St. Louis, Mo.

*Principal Assistant Engineer, Brenneke & Fay, St. Louis, Mo.

under similar conditions, it was decided to use 25 tons per pile, and one ton per sq.ft. in bearing on the filled soil, or two tons per sq.ft. on the underlying material. It was also decided to use piles 25 ft. long and about 4 ft. in circumference, which would make the skin friction about 500 lb. per sq.ft.

It was found that the plain concrete pedestals and the concrete pedestals with reinforced-concrete footings were

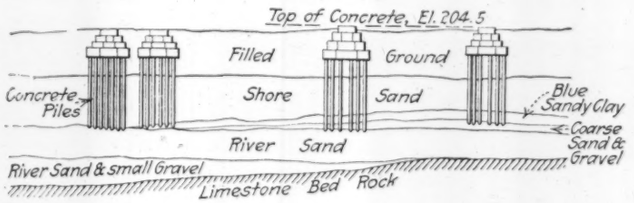
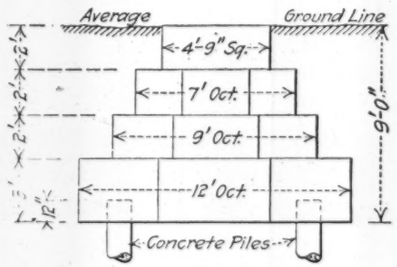


FIG. 2. PART PROFILE, SHOWING STRATA, WITH CONCRETE PILES AND PEDESTALS

not economical, owing to the depths to which it was necessary to carry them, and to the low-bearing value used on the soil. Under the loading used, the plain concrete shafts extending to the rock were found to be more economical than the pile foundations, to a depth of about 35 ft., assuming that no unusually soft strata were found, which would cause difficult excavation. The concrete shafts to rock are, of course, more economical for heavy loads than for light ones. In comparing the various types of foundations, the six piers of one tower were considered



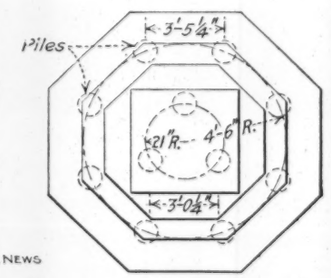


FIG. 3. TYPICAL PEDESTAL PIER FOR COLUMNS OF VIADUCT

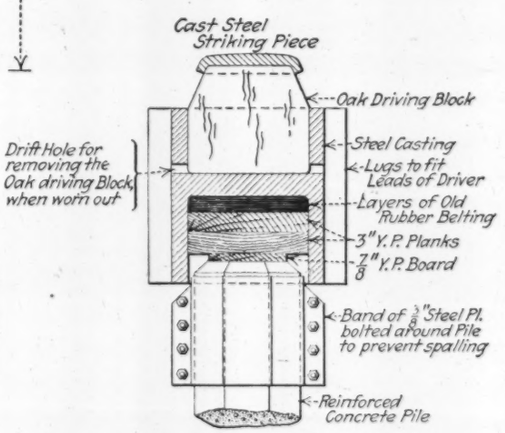

Cast Steel Striking Piece
Oak Driving Block
Steel Casting
Drift Hole for removing the Oak driving Block, when worn out
Lugs to fit Leads of Driver
Layers of Old Rubber Belting
3" Y. P. Planks
7/8" Y. P. Board
Band of 3/8" Steel Pl. bolted around Pile to prevent spalling
Reinforced Concrete Pile

FIG. 4. CAP USED IN DRIVING CONCRETE PILES

of these points, owing to a stratum of fine water-bearing sand overlying the rock at these points. The stratum was encountered when sinking the first shaft of bents 15 and 29, and after attempting unsuccessfully to put down the open shaft, it was abandoned and piles were later driven to rock. Fig. 2 is a portion of the profile, showing the strata, with concrete piles and pedestals. Fig. 3 is a detail of one of the pedestals.

COMPARATIVE ESTIMATE OF COST OF FOUNDATIONS

The estimated cost of these two types of foundation for tower No. 15-16 is given in Table I. In this case the average depth of rock below the ground surface, as taken from the boring sheet, was about 31 ft. The yardage cost of concrete includes cost of forms, and that of excavation includes sheeting, shoring and pumping.

TABLE I.—COMPARATIVE ESTIMATE OF COST OF FOUNDATIONS FOR TOWER NO. 15-16

	Concrete Shafts		Concrete Piles	
Concrete, cu.yd.	302.3@$5.70	$1725	127.8@$5.70	$728
Excavation, cu.yd.	325.5@ 1.75	570	216.4@ 0.60	130
Ft. con. piles, lin.ft.			1550 @ 1.10	705
Total for 6 piers		$2295		$2563

MANUFACTURING AND DRIVING CONCRETE PILES

The specifications called for piles of the pre-molded type. The length, superficial area and percentage of reinforcement were specified, but the cross-section and the taper were left to the contractor. It was also specified that the piles must season at least 30 days before driving and that they were to be driven by means of a steam hammer.

Pile-making was started late in the fall of 1911, and continued with some interruptions (due to cold weather) until the last of December, when it was stopped for the winter. The piles were of octagonal cross-section, 14 in. short diameter, 25 ft. long over the point. They were

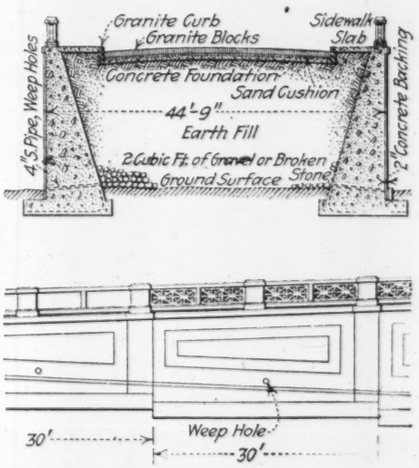


FIG. 5. CROSS-SECTION AND PART ELEVATION OF APPROACH FILL

together. It was not thought advisable to use concrete shafts (to rock) and pile foundations in the same tower, because of the probability of unequal settlement and consequent straining of the superstructure.

It was intended originally to use pile foundations for Bents 1 to 13, inclusive, and for those west of bent 30; and to use concrete shafts sunk to rock for bents 14 to 30 inclusive. During construction it was found necessary to use pile foundations in place of concrete shafts at four

reinforced with six ⅝-in. round longitudinal bars, wound with a spiral of No. 9 wire on 4-in. pitch. This pitch was reduced to 1 in. for about 18 in. at the head of the pile. At the point the six bars were drawn together and wired. The total reinforcement amounts to 1⅛% of the volume of the pile. A 1:2:4 mix was used, with gravel ¾ in. diameter and under for the coarse aggregate. The heads of the piles were made richer by the addition of about a quarter sack of cement to the last barrow of con-

crete. This, and the closer pitch of the wire spiral at this point, was intended to make the head of the pile tougher and better able to stand hard driving.

In fabricating the reinforcing units, the bars were fastened to wooden collars mounted on a 4-in. pipe mandrel supported on two frames about 26 ft. apart. The wire for the spiral was mounted on a reel and one end of the wire attached to one end of the bars. The mandrel was then turned slowly by a handle and the wire wound onto the bars. After the winding was completed, the spiral was wired to the bars at short intervals, the collars were removed, and the mandrel slipped out. The bars were then wired together at the point, and the reinforcement was ready to suspend in the form. A rather wet mix was used, care being taken to work the concrete into all corners, and to keep the gravel back from the surface. The forms were set side by side, 25 forms being set up each time. Concrete was brought from the mixer in barrows. Usually 25 piles were molded in a day. After setting two or three days, depending on the weather, the side forms were removed, leaving the piles resting on the bottom of the forms, an extra set of which was provided. As soon as the piles could be safely handled, they were rolled aside and left to season. The 50 forms and 50 extra bottoms were used throughout the work.

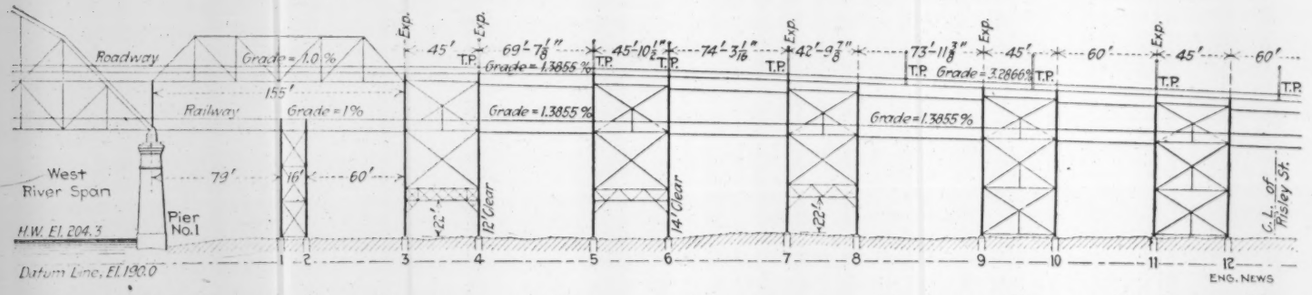


FIG. 6. PART LONGITUDINAL ELEVATION OF VIADUCT APPROACH TO THE MUNICIPAL BRIDGE; ST. LOUIS, MO.

Pile-driving began late in January, 1912, and continued until the early part of June, with occasional layoffs due to bad weather and other causes. At first some difficulty was experienced in driving, owing to the hardness of the material near Pier I, where work was started. A cushion composed of layers of rubber belting was placed on top of the pile to absorb the shock. The driving head was arranged as shown in Fig. 4. It was found that as long as the blow could be concentrated at the center of the pile head, there was but little injury to the pile. When, however, the driving block became cupped, the blow was delivered on the circumference of the pile head, with the result that the head of the pile spalled, leaving the bars exposed. In some cases the reinforcement became bent and the head of the pile had to be cut off, and a new start was made. During the hardest driving a ⅜-in. steel band, about 15 in. wide, was bolted around the pile head, to prevent spalling; this was very effective.

The driving for the first 300 ft. was exceedingly hard. Many obstructions were encountered. In one place piles had to be driven through an old macadam roadway, which had been filled from time to time until a thickness of several feet was reached. The piles east of 1st St. came to a practical refusal, sometimes at several feet above the proposed elevation. In many cases piles stood 40 to 80 blows to the last inch. West of 1st St., softer material was encountered, and most of the remaining piles drove to the desired elevation, bringing up at from 4 to 20 blows to the last inch. In order to facilitate the handling of the driver, the piles were driven before excavating, except when they were driven in cellars. The piles were driven below ground surface by means of a follower having a steel band on the lower end, which slipped over the pile head and tended to prevent it from spalling.

In spite of the hard driving, little injury was done to the piles; as subsequent excavation proved. Aside from eight piles which broke in driving, due to the setting of the concrete having been retarded by cold, the only injury done was the spalling of the heads. Most of the heads were uninjured after sustaining upward of 2000 blows of a No. 2 Vulcan steam hammer. In all, 767 piles were driven, including the eight which were broken. In these broken piles it was found that the outer concrete (to a depth of about 2 in.) had set up hard, inclosing a core of green concrete. The remaining piles of the same batches were set aside and left to season until warmer weather, when they were driven without difficulty. Samples of the green concrete from the cores of the broken piles set up hard on being left for two or three days in a warm room.

The piles made in warmer weather did not spall as easily as those made during the winter, probably due to better setting of the concrete. Toward the last, the band and the rubber cushion were dispensed with and only a piece of pine plank was used beween the top of the pile and the driving blocks inside of the cast driving head. The total number of full working days of ten hours was 85, making an average of about nine piles per day, while the maximum number was 18. This was good work considering the amount of cribbing and moving that had to be done. When piles had to be cut off, the concrete was broken away from the bars by means of a chisel bar and sledge. The bars were then cut with a hacksaw, or cold chisel and sledge, and the pile head knocked off.

The piles for each pier were arranged in concentric circles and the courses of the concrete pedestals were made octagonal, as shown in Fig. 3. With this arrangement any desired number of piles could be used, and an excess avoided. In general, piles were spaced about 3 ft. c. to c.

CONCRETE SHAFTS ON BEDROCK

The concrete shafts extending to rock were made 7 ft. square, this being considered the minimum size in which the men could work to advantage. The first few feet of excavation was thrown out with shovels, then a lining of 2-in. planks was placed, the inside dimensions of the

lining being the size of the finished shaft. This lining or open caisson was sunk by excavating the material underneath it and weighting it so that it would follow down.

The excavated material was taken out by means of 1-yd. buckets which were handled by a derrick so placed that it could reach the six pits of each tower. When soft material was encountered, sheet-piling of 2-in. plank was resorted to. This served to hold back the material, except when the water-bearing sand was encountered. This sand was very much like quicksand and after making an attempt to get through it and down to rock by sheet-piling, it was decided that it would be cheaper to adopt pile foundations for these particular bents, as mentioned above. On reaching rock, it was cleaned off and in one pit of each bent a drill hole about 3 ft. deep was put down to test the rock. No ledges were encountered, however, and the shafts were concreted. The plank lining was left in place, as it was found cheaper to abandon the lining than to remove it and fill the additional space with concrete.

Locating Piers and Setting Anchor Bolts

All piers are located with reference to the center lines of the structure on tangent, or to these tangents produced. The center line of the river spans was first produced through the freight yards and freight sheds lying between Pier 1, and the west line of 1st St., and was continued as far west as the first point of intersection. The other tangents were tied in with the center line of the river spans. At the intersection of these tangents with each bent a hub was set, the angle between the bent and tangent turned off, and hubs or marks on curb or walls were placed on the bent lines.

The distances between centers of bents along the tangents were repeatedly measured by means of a 100-ft. steel base-line tape, which had been compared with the tape used at the bridge shop for laying out the steel work. A spring balance was used to give a uniform tension on the tape, and correction was made for temperature. Some difficulty was experienced in carrying the measurements through the freight sheds and yards, owing to numerous obstructions. Measurements were repeated until those between bent centers agreed to $\frac{1}{16}$ in. after all corrections were made.

Hubs were then placed at the site of each pier center and referenced, so that they could be readily replaced. These lines were used for locating piles, limits of excavations and pier forms. They were then checked and used to locate the anchor bolts, which were set in the usual manner by wooden templates located by transit and chalk lines. Each group of bolts was provided with an anchorage which served to properly space the bolts at the bottom, and to keep them vertical. The distance between centers of adjoining piers was checked from the centers marked on the anchor-bolt templates before the bolts were concreted in, and again after concreting was finished.

Retaining-walls

The highway structure from 6th to 7th Sts. is carried on an earth fill inclosed by retaining-walls of the semi-gravity type, Fig. 5. These walls are surmounted by reinforced-concrete railings of somewhat elaborate design. The walls are paneled and pilastered for appearance sake. The railway approach from 7th to 8th St. is carried in a similar manner, but has a retaining-wall along the south side only, the enbankment sloping to Gratiot St. on the north. There is no railing on this wall, and the paneling is omitted except for the abutment, which faces 7th St. The coping and pilasters were also omitted on the railway wall.

The walls were constructed in alternate sections. The length of each section of highway walls is 30 ft. c. to c. of pilasters, and the length of each section of railway wall is 25 ft. Expansion joints occur between each two sections of walls. These are merely tongue-and-groove joints, with several thicknesses of tar-paper to form a compressible joint.

The mix for the walls and piers was 1:2½:5, and for the railings 1:2:4. Gravel was used for the coarse aggregate in all cases. Owing to the fact that the highway retaining-walls are contiguous to important streets, special pains were taken to get a good finish on the walls and railings. The forms for the walls were made of 2-in. dressed lumber with 4x6-in. studs. The faces for the exposed surface of the concrete were carefully dressed to remove all lips and ridges, the forms were wet down before concreting started, and all cracks were carefully puttied up flush with the boards, to prevent leakage, and board streaks. The concrete was handled from the mixer to the work by means of a movable stiff-leg derrick, carrying a 1-yd. bottom-dump bucket. A rather wet mix was used, and the concrete worked away from the forms with a spading fork, which allowed the mortar to flow between the tines to the face of the wall, while the coarse aggregate was held back.

Fig. 7. View of Bridge Approach

[Showing offset of highway deck (connecting with upper deck of bridge) to a position alongside the railway deck (from lower deck of bridge).]

As soon as the forms were removed, the exposed surfaces of the work were painted with a thin grout of neat cement, and rubbed down with carborundum blocks. The

surplus grout was then washed off with a hose, and the process repeated, if necessary, until all rough places had been rubbed down and all pinholes and other small cavities filled. By this means, a very uniform and pleasing finish was obtained, which would not flake or skin off, as the grout was rubbed into the pores of the wall and there was no excess on the surface.

The railing, with the exception of the posts, was cast on the ground, erected and grouted into place. Forms for the various portions of the railings were made in a shop, and were painted with a paraffin oil. The forms were made collapsible, so that the sides, ends and cores could be readily removed, leaving the members resting on the form bottoms. The railing was given a trowel finish on all faces that could be reached, and after the forms were removed, the surfaces were gone over (where necessary) with carborundum blocks. In erecting the railings, the forms for the posts were set up around reinforcing rods, which had been built into the wall and projected nearly to the tops of the posts. The foot rails were placed, then the panels and hand rail. The railing was lined up from a transit line, the posts were concreted, and the joints in the railing were grouted and pointed up. An expansion joint was provided at each railing post, similar to those in the walls.

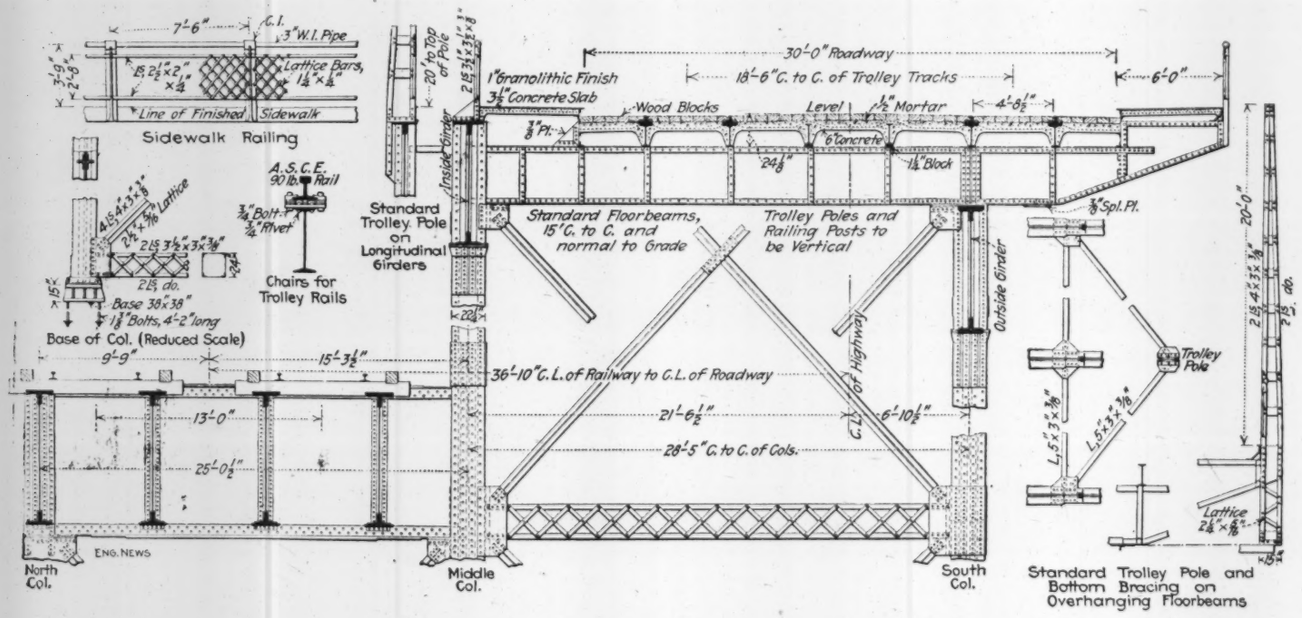


FIG. 8. TYPICAL SECTION OF COMBINED RAILWAY AND HIGHWAY APPROACH TO THE MUNICIPAL BRIDGE; ST. LOUIS, MO.

STEEL SUPERSTRUCTURE

The superstructure consists in general of steel girder spans on braced towers. Just west of Pier 1 there is a 155-ft. riveted span carrying the highway over the railway turnouts which are provided to take care of possible future railway connections from the north and south. Fig. 6 shows the typical construction and also the truss span noted above. Fig. 7 is an end view of the offset of the highway deck to its position beside the railway deck on the approach. Another riveted truss span carries the highway and railway structures over Broadway. All other spans are of the deck plate-girder type. The ruling length of spans is 45 ft. for the towers, and 75 ft. for the clear spans. Expansion joints are provided at each tower. The structure is designed for Cooper's E-60 loading on the railway tracks, and for 35-ton electric cars and an 18-ton road-roller on the roadway. The sidewalks are designed for a live load of 100 lb. per sq.ft. Carbon steel is used throughout. The unit stresses used in designing are the same as those used in the design of the carbon-steel portion of the river spans.*

The arrangement of the columns was complicated by the surface tracks, and by the proposed track elevation of the St. L., I. Mtn. & So. R.R. at Broadway. The required clearance over this proposed elevated structure also determined the grades on the approach and the depth of the floor system of the truss spans over Broadway. As indicated on the cross-section Fig. 8, the north railway stringer is riveted to the floor-beam directly over the column on top of which the floor-beam rests. The other end of this floor-beam is riveted to the web of the center column. The distance from the north to the middle column of the bent is determined by the spacing of the tracks and the necessary clearance between the cars on the south track, and the middle column.

The street-car rails are supported on 15-in. I-beam stringers, with fiber pads (shown on the detail) to reduce the impact. These stringers rest on transverse riveted floor-beams, having cantilever extensions to carry the south sidewalk. The floor-beams in turn are supported on longitudinal riveted girders, which frame into the middle and south columns of the bent. The north trolley rail of the south track is directly over the south column, and the entire sidewalk on that side and a portion of the roadway is carried on the cantilever end of the floor-beams.

The columns are of a modified H-section, having a built I-shaped web or diaphragm, and two built channels,

*Engineering News, Feb. 8, 1912.

with the flanges turned in and laced. The columns are composed entirely of plates and angles. With the exception of the horizontal struts, all tower bracing and knee braces consist of four angles arranged in the shape of an I, and laced. The columns rest on cast-iron bases from 15 to 18 in. high, set on a bed of mortar on the piers, in the same manner as a cap stone. The anchor bolts (four in each pier) in general extend through these castings and the base plates of the columns. In some few cases where the base castings are unusually large, the anchor bolts extend only through the bedplates of the castings, and separate bolts are used to secure the columns to the castings.

The heaviest member in the structure is the south longitudinal highway girder spanning 4th St. This girder is 90 ft. long c. to c. of bents, 8 ft. 6½ in. deep over the flange angles, and weighs 42 tons. The web plate is ½ in. thick and each flange is composed of two angles 8x8x1

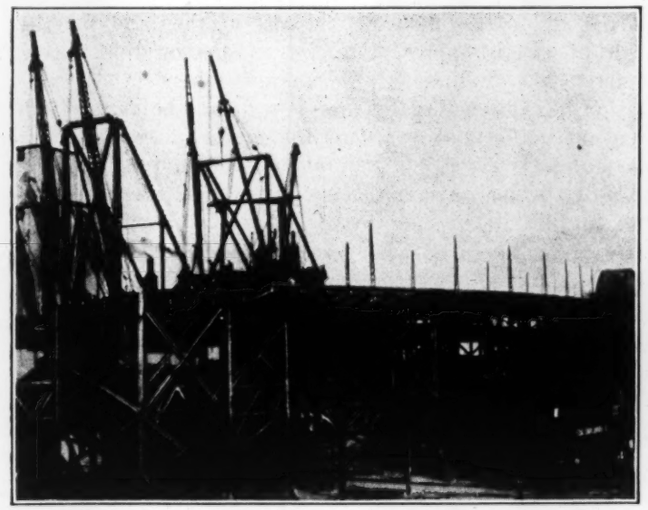


FIG. 9. FOUR ERECTION TRAVELERS ON THE MUNICIPAL BRIDGE.

(Two on the lower or railway deck, and two on the upper or highway deck).

in., three cover plates 20x⅞ in., and two 20x⅛ in. The stiffeners are 6x3½x$\frac{7}{16}$-in. angles. The west end of this girder is riveted to the transverse girders of bent No. 31. This transverse member has a span of 38 ft. ½ in. c. to c. of columns, and is chiefly remarkable for its depth, 12 ft. 2¼ in. over flanges. The web plate is ½ in. thick, and each flange is composed of two angles 8x8x$1\frac{5}{16}$ in. The unusual depth is due to the fact that the top flange is in the plane of the bottoms of the I-beam stringers, thus taking the place of the regular floor-beam, while the bottom flange is sufficiently below the bottom flange of the 90-ft. longitudinal girder to allow the latter to be riveted to the web of the former.

ERECTION OF THE SUPERSTRUCTURE

The steel-work was erected by means of two mule travelers, one on the railway and the other on the highway deck, as shown in Fig. 9. These were assisted by the locomotive crane working on the surface tracks mentioned above. The railway traveler was the one used previously for placing the falsework bents and railway-floor system of the river spans. To suit the conditions met with in erecting the approach, it was remodeled by adding 10 ft. to the length of each boom and lowering the engine deck, which (for the river spans) had been high enough above the track to allow material cars to be passed under the traveler from the rear. On the approach, all the material was picked up from the ground in front of the travelers. This made it possible to place the engine decks close to the track, thus making the traveler more stable. Each traveler was equipped with two steel masts and booms and was operated by two steam hoisting engines. The booms of the railway traveler were 80 ft. and those of the highway traveler 50 ft. in length, with 10-ft. extensions on the highway booms for runner lines.

The railway traveler worked in advance, and placed most of the columns and bracing and the material for the railway (lower) deck. The highway traveler was

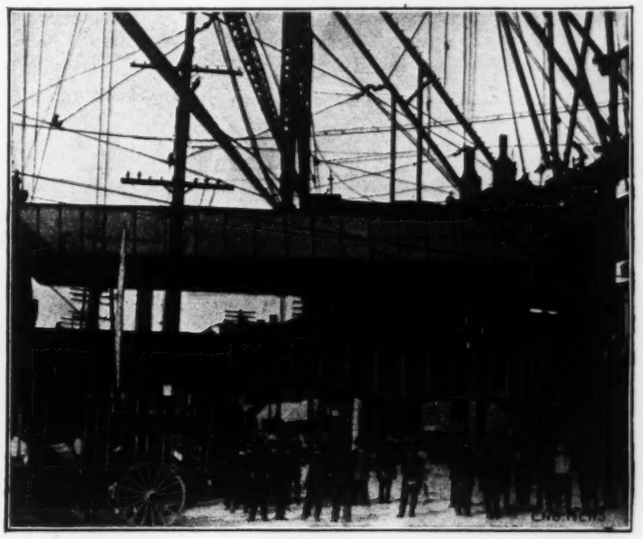


FIG. 10. TRAVELERS ERECTING 90-FT. 42-TON GIRDERS OVER 4TH. ST.; ST. LOUIS, MO.

erected on the upper deck of the river spans, and erected the 155-ft. riveted span extending from Pier 1 to bent 3. The falsework for this span was supported on the girders of the railway deck below. The top laterals and such other members as would have interfered with the passage of the traveler were handled by an auxiliary boom rigged on the rear end of the highway traveler. After completing the erection of the riveted span, this traveler followed up the railway traveler, and placed the highway-deck material, and such other members as had not been placed by the other traveler. The locomotive crane was provided with a 60-ft. boom. The cast column bases east of 4th St. and some of the columns and bracing were set by this crane. West of 4th St., the cast-column bases had to be set by hand, using a timber tripod equipped with chain blocks, and handled by a crew of five or six men.

When 4th St. was reached, a timber bent (framed for the purpose) was set upon the west side of the street, and the four railway girders placed in position, with their west ends cantilevered some 20 ft. beyond the bent. The railway traveler then advanced on the girders far enough to be able to raise the transverse girders of bent No. 31, and bolt them to the ends of the railway

girders. The columns and bracing of bent 31 were next placed in position, and the girders lowered slightly on the blocking until the transverse girders could be bolted to the columns. The next step was to erect the remainder of tower 31-32, which was done to afford a secure anchorage for the railway traveler, while raising the forward end of the 90-ft. 42-ton highway girder (described above). This girder was first picked up by the traveler (using both booms), moved out across the street into a position about parallel to its final position and left on blocking.

The traveler was then moved ahead, lashed down, and the north boom anchored to the steelwork of tower 31-32 to give greater stability to the traveler while making the heavy side lift. The south boom of the traveler raised the west end of the girder, and the east end was handled by the highway traveler, which had a direct forward lift. The load was about equally divided between the two travelers. The portion of the load raised by the highway traveler was divided between the two booms by evening beams attached by heavy dogs to the flanges of the girder. The erection of this girder is shown in Fig. 10. The riveted truss spans over Broadway were erected on timber falsework in the usual manner.

The total amount of steel and cast iron in the approach, exclusive of the railway structure west of Broadway, is about 7225 tons. All riveting was done with pneumatic hammers. The total number of field rivets is about 133,000, or about 18 per ton of metal. The estimated weight of the railway structure west of Broadway is about 810 tons, making a total for the approach of 8035 tons.

Contractors' Plants

The plant of the foundation contractor consisted of a movable stiff-leg derrick with a 50-ft. timber boom; this was used for handling the earth from the excavations, placing the forms for the walls, and placing concrete. There were also two mixers of ½-yd. capacity, and a pile-driver so constructed that the leads could be lowered (by revolving them about a horizontal axis) when the driver was being moved under wires, etc. The equipment of the superstructure contractor consisted of the two viaduct travelers described above, a derrick car, and a locomotive crane for unloading and handling material; also two air compressors with the usual equipment of receivers, pneumatic riveters, etc. The Missouri Valley Bridge & Iron Co., of Leavenworth, Kan., had the contract for the foundations, and the American Bridge Co. furnished and erected the superstructure, which was fabricated at the Gary plant.* The former company was represented on the ground by Jerome Wilhelm, who resigned about the middle of January, 1912, to take a position with another company. He was succeeded by S. W. Crocker. The American Bridge Co.'s work was in charge of Paul Johnson, assistant engineer, and Chas. Webster, general foreman.

Owing to difficulty in acquiring certain portions of the right-of-way for the railway approach west of Broadway, this portion of the structure was not contracted for until Sept. 3, 1912, when the foundation contract was awarded to Fruin & Colnon, of St. Louis, and the metal work of the superstructure to the American Bridge Co. The foundation work for this portion of the approach is now under way.

*Engineering News, Aug. 8, 1912.

Total Cost of Approach

The cost of the highway retaining-walls and foundations and railway foundations from Pier 1 to the point of divergence of the two structures just west of Broadway, is given in the first part of Table II. This cost is based on the actual quantities, and the unit prices bid by the contractor.

The amount of the American Bridge Co.'s contract for the first portion of the structure, as described above, is $427,297, with a unit price of 3c. per lb. for additions or deductions. For the remainder of the railway structure, its contract price is $50,227; the unit price for additions or deductions in this case being 3.1c. per lb. The total cost of the approach, from actual contract prices and from estimates of certain portions, is given at the end of the table. The cost of the land for the right-of-way is approximate, for the reason that exceptions to the findings of the commissioners in condemnation have been filed by several property holders, which may make the final award by the courts in excess of the amount here given. The summary does not include the cost of the railway on the surface of Gratiot St., from 8th to 23d Sts.

TABLE II COST OF WEST APPROACH; ST. LOUIS BRIDGE

Section I.					
Piling	18,975	lin.ft.	@	$0.92	$17,457
Excavation	4,667.3	cu.yd.	@	1.55	7,234
Earth fill	3,150	cu.yd.	@	0.60	1,890
Concrete (piers)	2,924.5	cu.yd.	@	4.70	13,745
Concrete (ret. walls)	1,775.4	cu.yd.	@	5.10	9,055
Railings	545.5	lin.ft.	@	3.00	1,636
Anchorages	15,611	lb.	@	0.04	624
Trolley pole casings	3,040	lb.	@	0.04	122
Reinforcing steel	13,060	lb.	@	0.03	392
Total					$52,155
Section II.					
Piling	5,975	lin.ft.	@	1.25	7 469
Grading	400	cu.yd.	@	0.50	200
Excavation	1,150	cu.yd.	@	1.00	1,150
Earth fill	5,650	cu.yd.	@	0.25	1,412
Concrete (pier)	384	cu.yd.	@	6.50	2,496
Concrete (ret. walls)	1,150	cu.yd.	@	7.00	8,050
Anchorages	3,650	lb.	@	0.04	146
Reinforcing steel	7,300	lb.	@	0.04	292
Total					$21,215
Summary					
Substructure (1st contract, actual cost)					52,155
Substructure (2nd contract, estimated)					21,215
Superstructure; metalwork (1st contract)					427,297
Superstructure; metalwork (2nd contract)					50,227
Paving for highway approach (estimated)					66,000
Track work for railway approach (estimated)					28,000
Station buildings (estimated)					26,000
Right of way					561,530
Total exclusive of engineers' fees					$1,232,424
Or in round numbers, say					1,250,000

Engineers

The approach, with the exception of the substructure, was designed by Boller, Hodge & Baird, of New York, the consulting engineers of the work. Local matters are in charge of Brenneke & Fay, resident engineers, of St. Louis. This firm also designed the foundations and retaining-walls, subject to the approval of the consulting engineers. The writer, as principal assistant engineer for Brenneke & Fay, supervised the work of construction, and the preparation of the substructure plans. He wishes to express his appreciation of the careful work of his assistants: C. S. Johnson, A. R. Ross, W. R. Johnson and R. D. Spradling, who laid out and inspected the work in the field, and L. H. Faidley and P. F. Michael, who prepared the substructure plans.

Engineering Progress in the U. S. Navy*

By C. W. Dyson†

In preparing an article under this heading, the ground to be covered is of such large extent that, in the greater part, nothing but the merest notice of improvements can be given, and only the most important points of progress will be detailed. The first and most important point of all, as reacting upon the general efficiency of the Navy as a reliable and economical fighting force, is the choice of propelling machinery for heavy vessels of moderate speed.

In the selection of the type of machinery to be used in the above class of vessels, the following points must be taken into consideration:

(1) General character of the service which the vessel will be called upon to perform, whether she must keep the sea for long periods, cruising at speeds very much lower than her maximum speeds, or whether she will be called upon for very little slow cruising, but must be held in readiness for dashes at high speed from a base to any threatened point.

(2) Greatest economy to be realized at the conditions under which she will be called upon to operate. This factor is important, not only from the standpoint of financial saving in reduced fuel cost, but, in the greater ease of fuel supply due to the decreased demands.

(3) Fuel capacity required by the demands of the service to which the vessel may be subjected.

(4) Ease of upkeep of the machinery, and degree to which the vessel, so far as machinery repairs are concerned, can be made self-supporting.

(5) Reliability of machinery when driven at high powers.

(6) Minimum weight and space required for the propelling machinery.

(7) Efficiency of propellers for maneuvering.

(8) Minimum obtainable vibration of hull due to machinery in operation.

(9) Effect of vertical position of center of gravity of the machinery upon the time of roll of the vessel, in fixing the quality of the vessel as a gun platform.

The question of costs of the different types of machinery will not be considered in comparing the relative advantages of the types, and the relative values of turbine reduction gear, electric propulsion and internal-combustion engines for propulsion will not be dealt with, because they are still more or less in the trial stage and sufficient data are not yet available to allow of a fair comparison.

Eliminating these three latter methods of propelling naval vessels restricts the choice of machinery for this purpose to the three following methods:

(a) By means of reciprocating engines.

(b) By means of steam turbines, impulse, reaction, or a combination of the two.

(c) By means of various combinations of reciprocating engines with turbines.

RECIPROCATING VS. TURBINE ENGINES

Maximum Economy and Fuel Capacity—Formerly, the favorite method of comparing the relative economies of propulsion of reciprocating engines and turbines was by comparing the water per shaft horsepower of the turbines with the water per indicated horsepower of the reciprocator, in this comparison all mention of the large difference between the indicated horsepower required in the one case and the shaft horsepower in the other being carefully neglected. The method of comparison in use today is the commercial one of "pounds of fuel per knot" at different speeds.

From a study of the operating characteristics of battleships driven by each class of engine, the following conclusions seem justified, under present economic conditions and engine design practice:

Should the duties of a vessel be such that she is required to steam for long periods and long distances at speeds much lower than her designed maximum speed, a less fuel expenditure per day will be required, and consequently a greater cruising radius will be obtained and less frequent recoaling necessitated, should reciprocating engines be fitted rather than turbines for propelling purposes.

Should the vessel operate from a fixed base, only doing sufficient cruising to insure that the machinery is kept in efficient condition in readiness for forced runs to any threatened point, the value of fuel economy at low speeds becomes minimized and, where the maximum speed of the vessel does not exceed 21 to 22 knots, either turbines or reciprocating engines may be used, the choice being dependent upon other factors than economies, which are practically equal at these speeds.

In other words, for the conditions (2) and (3), under which the American battleship fleet operates, the reciprocating engine is preferable to the turbine as a propelling engine. The Navy Department is, however, thoroughly alive to the advantages to be gained by adopting rotary in place of reciprocating motion in the main propelling machinery of the heavy vessels of the fleet, and, while recognizing the present advantages held by the reciprocating engine in the matter of economy at low fractions of designed power, holds itself ready to discard the reciprocating engine as soon as the turbine designers can demonstrate by actual performance that their claims as to equality of economy at low powers with the older machine have been realized. It was with this object in view that the department decided to install impulse turbines in the "Nevada," and not because the engineers of the department were "wobbling," as has been charged.

Ease of Upkeep of Machinery—The claim is frequently made by the turbine advocates that while the reciprocating engine, when new, is undoubtedly more economical than the turbine at small fractions of designed power, this advantage is soon lost in active service, due to excessive wear of piston and valve rings causing large losses through heavy leakage of steam, and that on the other hand, the turbines, not being subject to such frictional wear, retain their original economy indefinitely. Practical experience with both types of engine in actual service comes very far from justifying this conclusion. In fact, with intelligent supervision, the reciprocating engine, particularly since forced lubrication has been applied, holds its superiority continuously.

When reciprocating-engine vessels visit the navy yards for their regular overhaul, the work to be done on the main engines is practically nil, as the machine shops and foundries of the battleships are of ample capacity to take care of all repairs that may be necessary except such as the fitting of a new cylinder or the repair of a fractured bedplate. The above remarks apply only, however, to ships fitted with forced lubrication, where the wear of bearings and journals has been practically eliminated.

When we turn to the turbine engines, however, the case is quite the opposite. Fully 99% of the troubles that occur with this type of engine are internal troubles, and consist of erosion of blades and nozzles, stripping of blading, heavy corrosion of rotors, diaphragms and turbine wheels, causing destruction of balance. All of these troubles require a perfectly smooth haven in which to make repairs, and the majority of them require dock-yard facilities.

Evidence of experience leads, then, to the conclusion that a battleship fitted with reciprocating engines for propelling purposes is much less apt to be forced off her station by necessary repairs to her engines than is one fitted with turbine engines.

Reliability of Machinery When Driven at High Powers—From the nature of the two machines, it would appear to be safe to decide this condition as being distinctly in favor of the turbines, as this type of engine is completely free from all reciprocating parts held together by bolts and nuts. Experience with the "Delaware's" engines, however, lead to the conclusion that where proper care is taken to lock all nuts securely, and to effectively protect the engines against the shocks of reversal of direction of motion, the reciprocating engine can, even in this respect, be regarded as nearly on a par with the turbine in reliability.

The full-power 24-hour run of the "Delaware," made without preparation immediately after her arrival home from Chili, demonstrates this reliability of the present type of battleship engines very thoroughly. As stated, without any preliminary preparation of engines or machinery, the vessel put to sea, and upon getting well clear of the land a full-power run of four hours was started, during which time the vessel averaged 21.86 knots per hr. Without intermission the vessel continued on for 20 hr. longer, averaging for the full 24 hr. a speed of 21.3 knots, the ship automatically slowing down as the fires became dirty and the personnel fatigued. Upon the completion of the trial a radiogram was received from the commanding officer of the vessel reporting that not the slightest disarrangement had occurred to either the main engines or the auxiliary machinery, and that she was ready for immediate service.

Condition for Minimum Weight and Space Required for the Propelling Machinery—As already shown, the total heat units required to be absorbed by the boilers, both for Parsons turbines and for reciprocating engines, with battleships of the speed and power that now exist, is practically the same in both cases at full power. This indicates that, for existing conditions, nothing can be saved in the boiler-room weights

*Abstract of a paper before the Society of Naval Architects and Marine Engineers at the annual meeting in New York City, November, 1912.

†Captain, U. S. Navy.

or space by adopting turbines, as the same boiler power is required in the two cases.

In the engine rooms, for these powers, however, the reciprocating engine has a decided advantage in both weight and space required, but this advantage would disappear should the necessary power to be developed be increased considerably above what is now asked for, and the advantage would rest with the turbine. Should such an increase of power be called for in future designs, or should the ordinary cruising speed be made considerably higher than now used, the Navy Department would undoubtedly abandon the reciprocating engine and adopt one of its rotary rivals for the propulsion of its capital ships.

Efficiency of Propellers for Maneuvering—The relation of the backing powers of the vessel as compared with the maximum full power ahead, and the time required from full speed ahead until the vessel is dead in the water, is taken as a comparative measure of this condition. When all boilers are in use, which in the case of the "Delaware" occurs at 25,000 indicated horsepower for the main engine in the ahead motion, and for the "Salem" at 14,000 shaft horsepower for the main engine in the ahead motion, the maximum backing powers can be obtained. In the case of the "Delaware" this maximum backing power amounts to 89.2% of the ahead power, while in the turbine vessel "Salem" it amounts to only 41.9%. That is, at these points, the backing power of the "Delaware" is 2.13 times as great as that of the "Salem," both being expressed as fractions of the ahead power. At the maximum powers developed by the engines of the two vessels, the ratio of the percentage backing powers becomes: "Delaware" = 2.27 "Salem."

These results are further corroborated by the backing tests of the "Delaware" and the "Utah" upon their preliminary acceptance trials, where, with the "Delaware" going ahead at 21 knots and the "Utah" at 20, the times taken to bring the vessels dead in the water were, for the "Delaware," 1 min. 52 sec.; "Utah," 4 min. 44 sec. Backing power divided by ahead power is, for the "Delaware" 87.5%, for the "Utah" 35.7%. These results are still further corroborated by the destroyers, which can easily steam ahead at 16 knots under one boiler, but when called upon to maneuver invariably, as a matter of safety, start a second boiler.

Minimum Vibration of Hull; Steadiness of Hull as a Gun Platform as Affected by Machinery—In judging these points it seems only fair to base the decision upon the results of target practice of the vessels in service. If this is done, the decision could be given to the reciprocating type of machinery, as the "Delaware" has just won the championship of the battleship fleet, with the "Colorado," another reciprocating-engined vessel, standing second on the list. From these results it appears reasonable to state that, with well balanced reciprocating engines, no ill effects on gun fire should be expected.

Basing the choice between reciprocating engines and turbines, for battleship propulsion under existing conditions of speed and power, upon the above comparison of relative advantages of the two types, the advantage appears to rest most decidedly with the reciprocating engines, and the Navy Department has ruled accordingly.

COMBINATION SYSTEMS

In the search for economy of propulsion through a wide range of speeds, various combinations of reciprocating engines and turbines have been proposed, both by the Bureau of Steam Engineering and by the shipbuilders, but only one of the systems has as yet been authorized, and that one is for destroyers. It has not yet been tried out in service, but preliminary shop tests show a good gain in economy of the main propelling engines at cruising speeds. This system, as applied to the destroyers, depends entirely for its gain upon the greater efficiency of the reciprocating engine at the higher steam pressures over the efficiency of high-pressure turbines of the reaction type and the high-pressure nozzles of the impulse type of turbines, no advantage being gained from increased efficiency of propellers, as the reciprocating engines are on the same shafts as the turbines.

From some points of view this combination is undesirable, and the gain in service must be considerable to justify its retention. With the other combination systems proposed, calculations indicate that if the propulsive efficiency counted upon can be obtained, these systems will all be very much more efficient than either a straight turbine or straight reciprocating-engine drive at maximum power, will hold a big advantage over the straight turbine drive through all ranges of powers, and will hold its advantage over the straight reciprocating-engine drive until a minimum speed of about 11 knots is reached, when the efficiencies become equal. The "if" exists, however, and is caused by the danger of the currents thrown to the rear by the big reciprocating-engine screws seriously affecting the rate of feed and direction of flow of water to the turbine propellers. In addition, there may possibly be another source of loss due to heavy leakage of steam through the large change valves which must be fitted to control the paths of flow of the exhaust steam from the reciprocating engines.

In all of these systems, to adapt them to naval requirements, it is necessary to exhaust from the low-pressure cylinders of the reciprocating engines at a pressure of not less than 25 lb. absolute, when this engine is operating at full power, and to bypass as few of the stages of the turbine as possible in order to obtain an increased economy of propulsion through a large range of powers.

IMPROVEMENTS IN ENGINE DESIGN

The Parsons turbine as it exists in our vessels today is, with very few exceptions, the same as the turbines of this type which were fitted in the initial turbine vessel, the "Chester." The only improvements which have been made consist of changes in blade angles, particularly in the low-pressure stages, an increase in the number of rows of blades in these same stages, and the fitting of nozzles for the admission of auxiliary exhaust steam at several different locations along the steam path.

With the impulse turbine, however, the advance over the original naval turbines of this type, those of the scout "Salem," has been rapid. The number of stages has been very much increased, both in battleship and in destroyer turbines, a drum construction has been adopted for the lower-pressure stages, steam balance for propeller thrusts has been provided, cruising nozzles for low fractional powers have been fitted, and nozzles for utilization of auxiliary exhaust are now supplied as in the Parsons turbines.

That these changes in turbines of the impulse type have been accompanied by increase in economy has been thoroughly demonstrated by experience with the machinery of the destroyers, the economy of the impulse turbine showing up nearly, if not fully, as good as that of the reaction type. No opportunity has as yet been offered to obtain a measure of this economy increase with the battleship types of impulse turbine, nor will such opportunity occur until the "Nevada" is ready for trial.

The steps taken in recent years toward increasing the economy and reducing the weight of reciprocating engines have been: increasing of the steam pressure at the engine, improvement in design of engine framing, increasing of piston speed, use of a slight degree of superheat, reduction of cylinder clearances, decreasing of frictional losses through the steam ports, provision of positive circulation of steam through the steam jackets, reduction of back pressure in the low-pressure cylinders, increasing of the ratio between low-pressure and high-pressure cylinders with consequent increased ratio of expansion of steam, and also the application of forced lubrication to all journals, crosshead guides, eccentrics and thrust-bearings.

The following progress has been made in both reciprocating- and turbine-engine systems: Condensing apparatus has been improved, resulting in higher vacuum; rational designs of feed-water heaters have been introduced, based on the amount of water to be heated and the amount of auxiliary exhaust steam available for heating purposes, instead of on the old rule-of-thumb method of allowing a fixed number of horsepower per square foot of heating surface; steam-piping design has been based on the actual rate of flow of steam through the pipes as determined by tests in service; feed-pipe losses have been reduced to a minimum; evaporators and other auxiliaries have been improved; high-speed, electric-driven, forced-draft fans for battleships, and turbine-driven fans for destroyers have been adopted and finally oil fuel has been adopted to a certain extent for both battleships and destroyers.

Considering the above changes in detail, the steam pressures at the main engines have increased since 1895 from 150-lb. gage to 265-lb. gage in the high-pressure valve chest, resulting in a decrease in the size of engine cylinders and in the size of steam piping for equal units of power.

Since the design of the "Oregon's" engines was laid down, there has been a gradual increase in piston speeds used, from 900 ft. per min. in that class of boat to 1000 ft. per min. in the "Delaware" class. This increase of piston speed has been followed by a decrease in the weight of moving parts and has aided in holding down the weight and height of the engine, although the stroke has been increased from 42 in. to 48 in.

In the use of superheated steam the Bureau of Steam Engineering (Navy Department) has been rather conservative. There are at present seven vessels in the naval service fitted for superheat, the maximum degree of superheat obtained at the boilers being 85° F., which reduces to about 60° F. at

the engines. These figures are for full-power conditions and an increase in economy of about 6% is estimated to be obtained. At 12 knots, the cruising speed, the saving by the use of superheat hardly exceeds 3%. The first experiences with the vessels fitted with superheat were far from satisfactory, due to the rapid deterioration of the valves in the steam lines. These valves had cast-steel bodies and cast-steel valve disks with monel metal seats. The erosion and corrosion of the valve disks were very extensive, and in a short period of service it became necessary to replace the cast-steel valve disks with disks of monel metal. This substitution has been satisfactory and no further trouble has been experienced.

Reduction of clearance, decrease of frictional resistances of steam through the steam ports and reduced back pressures in the low-pressure cylinders have all resulted from a change in the design of engine cylinders and valve chests.

In the last ten years, the ratio of low-pressure to high-pressure cylinders for triple-expansion engines, has been increased from about 7:1 to 10:1, including clearances. This increase in ratio had been used previously in remodeling the engines of the "Cincinnati" and "Raleigh," with most excellent results. A serious mistake was made, however, in counting too much on the increased expansion obtained by fitting a smaller high-pressure cylinder than that originally installed, the steam pressure having been increased. The new high-pressure cylinder was made 24 in. in diameter and the ratio of low-pressure to high-pressure cylinder changed to about 11½:1. While the economy obtained with these engines was most excellent, the high-pressure cylinders were entirely too small and the engines have never developed the expected power.

By the adoption of forced lubrication for the main propelling engines, the engine friction has been enormously reduced. All the journals are oil borne so that no metal-to-metal contact occurs. The result has been that the amount of adjustment and overhaul of the main engines has been decreased to a very large extent, and the men who would have been used for this overhaul work can now be used on the auxiliary machinery to good advantage. This decrease in wear of the bearings, and the cushion provided by the oil, has resulted in a much better maintenance of alignment of the engines, has reduced shocks on the machinery and has reduced vibration due to these shocks. In addition, there is considerable saving in oil at ordinary speeds. At high speeds there still exists a heavy loss of oil, due to splashing on the cylinder heads and also to loss by evaporation from the hot surface of the lower heads. When first fitted, the forced lubrication gave trouble, due to oil being drawn through the low-pressure piston-rod stuffing-boxes. In order to remedy this defect, stuffing-boxes fitted with steam seals have been supplied, and later reports indicate that where the steam seal is properly fitted no trouble of this kind now exists.

With the advent of the turbine for marine propulsion, if the full benefit of the new machine was to be realized, a high vacuum in the condensers became imperative. In order to obtain such vacuums, the Parsons company originated the vacuum augmentor, and this addition to the condensing plant is used extensively in the naval service. In some vessels in the service, in place of the ordinary air pump with augmentor, air pumps of the dual type, as manufactured by Weir, have been fitted, while in other vessels both wet- and dry-air pumps have been used. Of these systems, that with augmentors and also the dual type appear to give the greatest satisfaction in service, and in addition require less weight and space than the wet and dry system.

The improvements in design of feed heaters, steam pipes and feed pipes naturally followed on the measurements of water consumptions of the machinery taken during the acceptance trials of the vessels. These measurements placed in the hands of the Bureau of Steam Engineering data of great value, and that bureau has attempted to use the full value of it in proportioning these important items. For instance, the feed heaters of the "Delaware" were, for lack of data, proportioned on the basis of so many i.hp. per sq.ft. of heating surface, and the two heaters combined have a total heating surface of 2100 sq.ft. In her sister ship, the "Utah," the same degree of feed heating is obtained with heaters having a total surface of only 512 sq.ft.

In the search for economy, the Bureau of Steam Engineering has adhered strenuously to the use of feed heaters with auxiliary exhaust steam as the heating medium, using any excess of exhaust in the low-pressure turbines or the second receivers of triple-expansion reciprocating engines. This utilization of the auxiliary exhaust has not been to the taste of the turbine manufacturers who prefer to use all of this steam in the turbines, depending for feed heat upon that derived from steam drains discharging into the feed tanks.

The improvements in evaporators consist mainly in the adoption of double effect connecting and in throwing open the gates to other than the standard bureau design, although these are not the only changes from former practice. Evaporator feed heaters using the vapor from the evaporators as a heating medium have been fitted, and vapor pipes, better designed for the amount they have to carry, are installed.

Until the adoption of electric-driven blowers for battleships and other large vessels and of turbine-driven blowers for destroyers and small vessels, the successful outcome of any heavy forced-draft run was always endangered by the unreliability of the blowers. Since the adoption of these types of blowers this danger of breakdown has been almost entirely eliminated, and, so far as the destroyers are concerned, the blowers may be classed as one of the most, if not the most, reliable of the auxiliaries fitted.

OIL FUEL FOR DESTROYERS AND BATTLESHIPS

In deciding to adopt oil fuel for use on battleships and destroyers, the Navy Department took into account the following advantages which are to be gained by its adoption: Less fuel is required for any given radius of action; consequently less percentage of displacement and less bunker capacity are required for the fuel; boiler efficiencies are increased; fire-room force is decreased; deterioration of boilers is decreased, due to maintenance of more even temperatures; high power can be maintained for indefinite periods; there is less deterioration of the ship's structure because of the absence of water and ashes in the bilges; greater cleanliness is obtainable; the fuel supply can be more easily replenished both in port and at sea; less floor space is required for the development of a given power; and the steam supply can be more easily controlled.

In opposition to these undoubted advantages the following disadvantages exist; that fuel oil is less widely distributed over the earth than coal, that its unit cost is greater than that of coal, and that its storage involves greater danger of fire than attaches to the storage of coal. The reply to the first objection is that in time of war a fleet operating far from a base would depend upon fuel ships, anyhow, for replenishing her bunkers and that oil can be carried in bulk as well as coal. Also, the bases where stores of oil can be kept on hand are as easily established as are bases for coal, and such oil bases would have, in case of danger of capture by an enemy, the additional advantage of being much more easily destroyed, together with their stores of fuel, than are coal bases. The second objection, that of excess cost of oil over that of coal, is more than counterbalanced by the advantages above stated. Finally, the third objection, that of danger from ignition of the ship's store of oil fuel, is very thoroughly guarded against by storing the oil in compartments remote from the boiler rooms and situated well below the water line of the vessel.

Upon deciding on the adoption of oil as a fuel for the naval service, the Bureau of Steam Engineering examined carefully all the systems for burning oil that now exist and finally decided upon that of mechanical atomization of the oil as the one most suitable for naval use. In this system, the oil is pumped through heaters to the burners within which it is given a whirling motion. The small central core of oil, discharging through the tip orifice with this whirling motion, the oil flies off and forms a cone of fine mist. This oil mist mixes thoroughly in the furnace with air which passes into the furnace through a cone register surrounding the burner, the register having adjustable openings and guide vanes so that the amount of air to each burner may be regulated and the direction of flow of this air be made slightly oblique to the axis of the cone of oil.

The success of the system depends almost entirely upon the proper handling of the air. Improper air regulation will produce a series of rapid explosions of oil in the furnaces with consequent destruction of their brick linings. With proper handling, the oil burns almost noiselessly, and the amount of smoke produced can be held under control.

In the first battleships fitted with oil fuel, the oil was only fitted as an auxiliary fuel and was intended to be used as an aid in keeping up steam when the coal should be so low as to be remote from the fire rooms and so require excessive trimming. The results obtained with this mixed system are not to be rated as good nor were good results expected, as the furnace volumes of coal-burning boilers are too small to permit efficient burning of oil. Furthermore, when burning the oil and coal in combination, it is impossible to so regulate the air supply that each fuel will obtain the proper amount. This results in excessive production of smoke and no increase in steam production over coal alone.

Block Signals and Interlocking Plants on the Chicago Great Western R. R.

The recent extensive improvement work on the Chicago Great Western R.R. includes the installation of automatic block signals on the Eastern Division from Chicago (Forest Park) to Oelwein Ia. (236 miles), and on the Northern Division from St. Paul to Randolph, 33 miles. The installation includes both double-track and single-track signalling. The length of the block sections ranges from one to five miles, varying with the traffic and local conditions. The apparatus was purchased from different companies, and was installed by the signal department of the railway. For information regarding the work we are indebted to Joseph Beaumont, Signal Engineer of the Chicago Great Western Ry.

Block Signals

The signals are of the semaphore type, with arms 4 ft. long and 9 in. wide, mounted on steel posts about 25 ft. high, having the mechanism in a box forming the base of the post. The signals normally indicate "clear," and the arms move in the upper right-hand quadrant, which arrangement is now becoming general practice. For double-track equipment, the arms have three positions, and there are no separate home and distant signals, as each signal serves as the distant signal for the one in advance. The positions and indications of the signals on double-track are as follows: horizontal ("stop"); inclined upward 45° ("proceed under control, next signal is at the stop position"); vertical ("proceed"). At night the signals show red, yellow and green lights, respectively, for the above indications.

For single-track equipment, the home signal has two indications only: "stop" and "proceed"; but a distant signal is placed 2000 to 3500 ft. before it, so as to advise enginemen of the position of the home signal and enable them to get their trains under control in case it is necessary to stop at the latter. The home signals show a red or green light, and the distant signals a yellow or green light. An exception to this arrangement is where the block is very short. In such cases, the previous signal is of the three-position type, serving as both home and distant signal, as in the double-track equipment described above.

The home signals are located at both ends of the passing sidings, and intermediate home signals are located along the block section where the distance is sufficient to require them. The home signals have square-end blades painted red, and the distant signals have forked-end blades painted yellow. All blades have the reverse side painted black.

Fig. 1 shows the signal equipment on double track near Maywood, Ill. The signal at the right is of the standard type, but the one at the left has a bracket with stub post representing the side-track which lies between the main track and the signal. Fig. 2 shows the home-signal equipment on single track, this being at the west end of the passing siding at Durango, Ia. Fig. 3 shows the single-track distant signal west of Budd, Ia., governing eastbound trains. Each signal has a 16-cell primary battery, and current for each track circuit is supplied by three gravity batteries. The concrete pedestal foundations for the signal posts are in three sections. They were manufactured at a division yard, thus avoiding small jobs of concreting along the track. The pedestals were distributed by cars, with other supplies, and were handled by the derrick car used for placing the concrete chambers for the batteries.

Fig. 1. Automatic Block Signals for Double Track, at Maywood, Ill.; Chicago, Great Western R.R., Joseph Beaumont, Signal Engineer

(The bracket and stub on the post at the left are on account of the side track between the main track and the signal.)

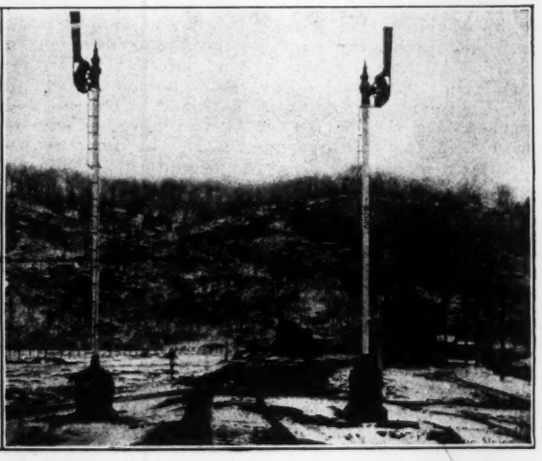


Fig. 2. Automatic Block Signal for Single Track, at the West End of Passing Track, Durango, Ia.; Chicago Great Western R.R.

Signal Control by Track Circuits

While the system by which the signals are controlled automatically through track circuits is familiar to many of our readers, there may be others to whom it is not clear. For the benefit of the latter, we give the two diagrams in Fig. 4, which are redrawn from similar diagrams in the instruction pamphlet of the Signal Department of the C. G. W. Ry. The following description is slightly condensed from that in the pamphlet mentioned.

The operation of automatic block signals is regulated or controlled by train movements through the operation of relays connected to the track circuits. A battery is connected to one end, and a relay to the other end of each track section

as shown in Fig. 4, the path of current being indicated by arrows. The various signal circuits are opened or closed by the relay contacts, which are so arranged in combination with the signal-control wire as to apply energy when conditions are safe for a train movement. The signal arm is so counterweighted that whenever the signal circuits are de-energized it will go to (and remain in) the horizontal or "stop" position. It will only assume a vertical ("proceed") position when the track is clear, the track circuits are unoccupied, and all relay contacts are closed in the track sections over which the signal governs train movements.

Each signal is operated from the "stop" to the "proceed" position by a small electric motor which is controlled by a circuit connected through the relay contacts. When the block is unobstructed, an electric current will cause the motor to rotate and put the signal at the "proceed" position. When a train passes the signal and enters the block, the wheels

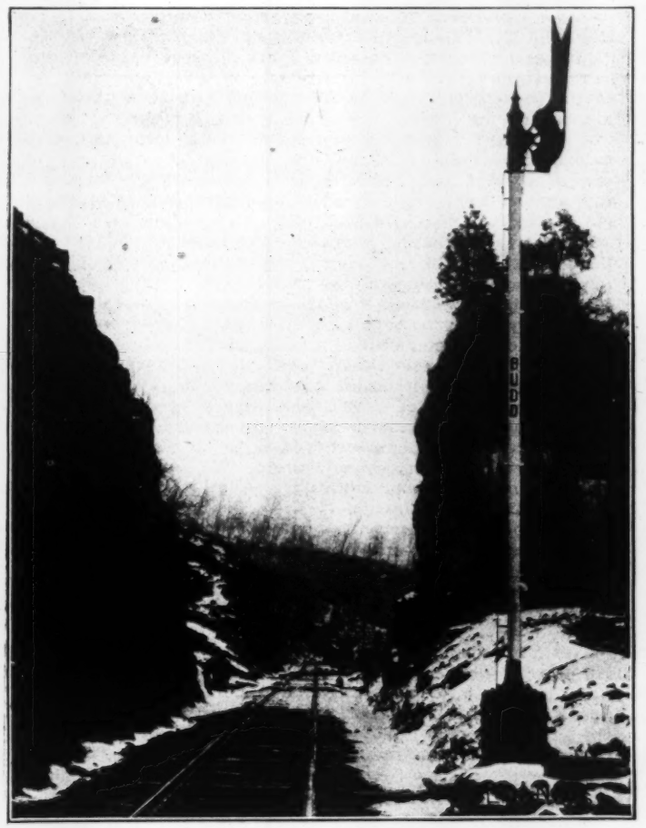


FIG. 3. AUTOMATIC DISTANT SIGNAL AT BUDD, IA.; CHICAGO GREAT WESTERN R.R.

and axles of the engine and car short-circuit the current flowing through the rails of the track, shunting the relay out of the circuit, as shown in Fig. 4. This opens the line circuit controlling the signal, disengaging the electric motor from the semaphore arm, which, being released immediately assumes the horizontal ("stop") position by gravity under the influence of the counterweight. The circuit remains open until the last pair of wheels has passed out of the block. Thus the signal indicates "stop" until the block is again clear and safe for an additional movement.

All switches in main tracks or leading to the main track in automatic signal territory are provided with circuit controllers, connected with the switch point as an operating medium, with wires bonded to the main track rails. If the switch point is moved from the main-track rail, the controller will short-circuit the track battery, thus shunting the relay out of the circuit and causing the signal arm to assume the horizontal position.

The rails of side tracks are so connected electrically to the main track circuit that a car or engine at the end of the side track close enough to the main line to foul a main track movement, will shunt the relay out of the circuit in the same manner as if the cars were on the main line. Thus, any movement fouling the main track will cause the inbound signal at each end of a block to assume the "stop" position. A broken rail or the removal of a rail from the track will open the circuit, thus causing the relay contacts to open, and putting the signal at "stop."

SWITCH INDICATORS AND LOCKS

At the switches of crossovers on double-track and at main-track switches located a considerable distance from the block signals, switch-indicators are installed to protect movements through the switches. The indicators are installed to protect movements through the switches. The indicator has a small box mounted on a short iron post close to the switchstand, and shows a miniature semaphore arm moving over a disk. When a train is on the main track in the block in which the switch is situated,

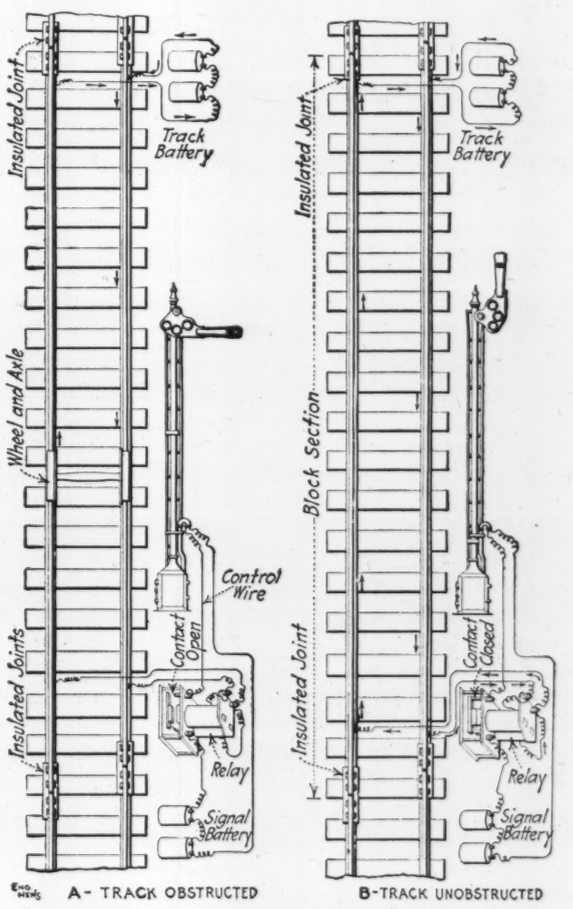


FIG. 4. DIAGRAM OF APPARATUS AND TRACK CIRCUITS FOR AUTOMATIC BLOCK SYSTEM

the arm of the indicator is horizontal ("danger"), showing that the switch must not be opened. If the arm is vertical, indicating that the main track is clear within the block limits, the switch may be opened. The movement of the switch then automatically sets the block signals at the "stop" position, so as to prevent trains from entering the section, and thus making it safe for another train to enter the section from the siding (and run to the end of the block section) or to cross from one main track to the other.

Some of the important crossovers have their switches equipped with electric locks so arranged that the switch cannot be operated unless the block section is clear. A train entering the block sets the switch-lock automatically. However, switching movements need not be delayed until after the train has passed out of the block, as

a release circuit just beyond the switch provides for the release of the lock as soon as the train has passed the switch.

Train-staff Block System

At several points on this road, and on tracks which it uses jointly with other lines, the traffic is operated under the protection of the train-staff block system. This provides for two or more consecutive following movements, or trains in the same direction, before any train movement is made in the opposite direction over the section thus controlled. But each following train must wait until the preceding train has passed out of the block before it can obtain the necessary authority to proceed.

Interlocking Plants

Interlocking plants at grade crossings with other railways include the mechanical, electrical and low-pressure pneumatic systems. In the first case, the various switches, signals and derails are operated by pipe connections, although in some few cases the signals are operated by wire. Where these plants are located in districts equipped with block signals, additional protection is provided by a combination of electric circuits and annunciators, electric slots, indicators and locks. These are so arranged as to give three functions: 1, to announce automatically the approach of a train; 2, to indicate to the signalman the condition of the track circuits through the limits of interlocking (showing whether or not the track is occupied), and 3, to automatically lock-up the route after a train has entered the limits, so that no opposing route can be cleared. Interlocking home signals operated by pipe connections are equipped with electric slot devices, so arranged that the semaphore arm will assume the "stop" position automatically when a train has passed the signal and entered the block. When the electric lock has locked up a route, the position of the switches can be changed only by a slow process which is purposely arranged with a view to requiring the signalman to consider his actions and thus preventing him from making a false move due to haste or impulse.

At electric interlocking plants, the motors for the signals and switches are operated by current from a generator driven by a gasoline engine; a storage battery of suitable capacity is in connection with this, and for small plants 60 amp.-hr. capacity is sufficient. A current of 110 volts is used generally. Each switch and signal motor is connected with the source of power through the necessary circuit-controllers and protective apparatus. The advantage of the electric system is that signals and switches can be operated at distances which would be impracticable with mechanical connections, while at the same time there is great ease of control. In the low-pressure pneumatic interlocking plant, the compressed air is used at 25 lb. pressure for transmission and 6 lb. for operating the apparatus.

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Cars for Disinfecting the Clothing and baggage of passengers who have been exposed to infectious diseases have been put into service on the Italian State Railways, according to the November, 1912, issue of "Rivista Tecnica della Ferrovie Italiane." Already two cars have been built, but it is expected that four more will soon be put into the southern part of Italy. Each car is completely equipped with two sets of disinfecting apparatus; one a steam stove system, and the other designed for the sterilization by the use of formalin. Each car is complete in itself, and is intended to be attached to a train coming out of a suspected or infected district.

Estimating the Cost of Garbage and Refuse Collection and Haulage in Chicago*

On July 15, 1912, the city council of Chicago passed an ordinance, directing the Civil Service Commission to make an investigation of the physical needs of the various wards of the city and of the systems and methods in use for the purpose of determining equitable ward appropriations for street and alley cleaning and refuse collection and removal. This work is done by the Bureau of Streets, Department of Public Works.

The city is divided into 35 wards. At the beginning of each year the council appropriates the money to be used in each ward for all operations of the Bureau of Streets.

The municipal refuse problem may be properly separated into four divisions: House separation, house collection, hauling and final disposition. Each division of the problem is so important that they should all be studied together and each weighed carefully in determining the final solution. Up to the present time the greatest study has been given to final disposition, yet this feature of the problem, as far as affecting the finances of the city, is of the least importance. Heretofore the whole problem has usually been handled as a condition to be met, rather than a problem to be solved. Collection and haul are the most important phases of the problem.

The city ordinance provides that rubbish and ashes shall be separated from garbage by the householders, and each kept in separate receptacles. Ashes and rubbish are collected together by wagons of 5 cu.yd. capacity and are dumped into large clay holes or into low marsh land.

In order to determine the costs of collection and the factors affecting it, study has been made as to time of collection, number of collections made each day by various teamsters, the service rendered, the rate of haul in miles per hour, location of dumps and the coöperation given the city's employees by the people served.

The peak quantity of garbage to be collected comes in the August and September canning season. Rubbish peak comes in the winter months.

The following tendencies have been found to control the expenditure necessary to care for these activities:

(a) Character of district.
(b) Population.
(c) Distribution of population.
(d) Location of dumps.
(e) Time required to collect.
(f) Time required to haul.
(g) Length of hauls.

A close study of Chicago conditions for the past several years show that a general law has been followed throughout the entire city in the matter of growth, and that set cycles of growth have obtained in the majority of districts in the past. While these cycles are changing, they are changing at a known rate, and this rate may be determined by studying the conditions for the past five years. The quantity of garbage and rubbish collected for each month of each year expressed in terms of percentage based upon January of that year, indicates that the quantity collected by months for any given district follows well-established cycles peculiar to that particular district.

These tendencies and cycles for a given district for the years 1908-1912 having been determined, it was comparatively easy to estimate what percentage of the January collection for 1913 may be expected in February of 1913. Carrying the same cycle through for March, the percentage for March was determined and so on. By getting the percentages between the Januaries of the various years by the same method, the quantity of garbage and rubbish that would probably be collected in January of 1913, was determined. As a further check upon this estimate, the percentage of garbage collected in one year over the percentage collected in another has been compiled for the past five years for each ward in the city.

As a still further check upon these estimates, the physical characteristics of the wards have been studied very carefully by investigators, engineers, and by others familiar with the conditions of each section of the city, and estimates made as to the increase or decrease that may be expected in the various wards in 1913.

Based upon conditions found to exist among efficient teamsters, the following units have been determined and used in formulating estimates: The average time required for

*Condensed from a statement sent to the technical press by F. H. Cenfield, Efficiency Engineer, Chicago Civil Service Commission, Chicago, Ill.

dumping has been taken as 25 minutes; the average rate of haul during the summer months at 3 mi. per hr.; and the average haul during the winter months at 2½ mi. per hr. In some of the outlying wards where it is very difficult to haul a load during certain months of the year, the number of months during which the men are allowed to make speed of 2½ mi. per hr. has been increased. Many writers upon the subject assume that a loaded team will make four miles per hour, but investigation of conditions existing here does not bear out these assumptions.

After studying the conditions very carefully in each ward of the city, it has been found that for the entire city the average time required for the collection of one load of rubbish averaged 1.7 hours in summer and 2.19 hours in winter.

The house collection of garbage is made by wagons equipped with steel tanks having a capacity of about 2½ tons of garbage. Each ward is divided into garbage districts and collections are made from each district by one driver according to the density and character of population. Under ordinary conditions it requires an average of approximately 3 hr. and 55 min. to collect a full load. Usually the greater number of garbage collectors collect one load per day and the remaining time is spent either in going to and from the loading station or disposal plant, or in waiting at the loading station.

All garbage which is collected from the north and west parts of the city is delivered either to the Chicago Ave. loading station or to the Oakley Ave. loading station, each of which is located on the north branch of the Chicago River. The garbage is transported by barge to the reduction plant at 39th and Iron Sts. The garbage delivered to these two stations in 1911 constituted 56% of the total garbage collected. For the first eight months of 1912 the cost of operation, maintenance and lighterage chargeable against garbage delivered at Oakley Avenue Station has averaged 75c. per ton, and at Chicago Avenue Loading Station, 64c. per ton.

To best comply with the ordinance regarding boxes in which to collect the garbage of the city, the city has used sheet steel tanks. These metal tanks are supplied with iron covers, attached by hinges with a common rod at the center of the top of the box. These tanks are loaded very heavily at times and receive considerable rough usage, both at the loading stations and at the reduction plant. The use that they receive on the barges in being transported from the loading stations to the reduction plant is especially deteriorating to the tank. The superimposed boxes rest directly on the boxes in the lower tiers and this has considerable to do with destroying the metal covers. Garbage contains considerable acid of various kinds, which has a tendency to remove the paint and destroy the metal. Many of the covers are completely gone and are being replaced from time to time.

With the rapid growth of the motor-truck industry, many questions have arisen as to the adaptability of motor trucks to the needs of various city departments. The Commission has made inquiries of municipalities and motor-truck companies regarding the adaptability of their product to the class of work which is done by the city. The "Engineering Magazine" published an article on the cost of operating motor trucks in the October, 1912, issue. The following table appeared in this article, showing the increase of operation with the increase in tonnage:

Size	Fixed charges	Increment per mile
1000 lb.	5.07	0.0886
3 ton	5.33	0.0860
5 ton	5.60	0.1253
6 ton	6.00	0.1540
7 ton	6.10	0.1718
12½-ton train	7.40	0.2070

The cost per day of the operation of a motor truck is equal to the fixed charges plus the miles per day times the cost per mile. This table indicates that the heavier the truck the smaller the cost of operation per ton capacity. It is very evident that the cost of hauling per ton mile by this method is considerably less than the cost per ton mile of hauling by team providing the truck can be kept in continual operation and in performing the work to which it is best adapted. There is no doubt that teams and wagons constitute the cheapest method of collecting garbage, rubbish and street dirt. Teams, however, constitute a more expensive method of removing garbage from the center of collection to the disposal plant, especially where the haul is any considerable distance, as exists in most sections of th city. In 'Engineering and Contracting," for Feb. 22, 1911, an article on the adaptability of motor trucks to contractor's uses appeared, contemplating especially the haulage of heavy materials, such as crushed stone, cement and lumber. These materials, however, differ very little from the material which the Bureau of Streets is required to handle as regards their bulkiness and weight. The motor tractor especially described in this paper is one so designed that it may replace the front wheels of an ordinary wagon and in this way furnish the motive power, as well as the front running gear. An apparatus required to make this change consists simply of a knee jack to raise the front of the wagon while the change is being made. With the adoption of a change of this kind, definite time schedules can be arranged for garbage, rubbish and street dirt collection or refuse wagons for a given district to deliver to a central station or yard.

There are a number of methods of garbage disposal carried on in different parts of the country, depending mainly upon the conditions existing. The following are the principal ones: (1) Reduction; (2) Incineration; (3) Land fills.

The advantages and disadvantages of reduction are as follows:

Advantages:

(1) Garbage changed into a product of commercial value and the addition of an industry to the community.

Disadvantages:

(1) Uneconomical for the city on account of the length of haul to a central reduction plant. For many sections of the city the haul is excessive and expensive.
(2) Labor employed must have considerable experience and skill.
(3) Large first cost of plant and high maintenance charges.
(4) Separate collection of garbage and rubbish required.
(5) Two separate systems of refuse disposal.

The advantages and disadvantages of incineration of garbage areas follow:

(1) Complete destruction of germs, organic matter and offensive gases of all municipal wastes.
(2) The reduction of length of haul, as small incinerators can be operated more economically than small reduction plants and can be established locally to meet the needs of local sections.
(3) Unskilled labor can be largely employed in the operation.
(4) No separation of refuse required.

Disadvantages:

(1) Is expensive, as there are no byproducts to help pay operating expenses.
(2) Unless experienced firemen are employed, results are not satisfactory or efficient.

Owing to the remoteness of certain sections of the city from the central garbage-disposal plant, the separation of refuse, as defined by the city ordinance, has been impractical and uneconomical. In these districts all house refuse has been collected together and has been disposed of in either low swampy lands or in clay holes. Up to the present time this method of disposal has met with very little objection. However, the time when this method will not meet the conditions of these localities is close at hand. The geographical locations of these districts and the character of population within them will make it practically impossible to economically obtain the proper separation of garbage from the other forms of house refuse, or to dispose of garbage at a central disposal plant. It will be necessary within a short period of time to devise some method of disposing of refuse in these districts in local plants.

A combination plant in which the salable portion of the refuse collected can be sorted and the balance destroyed by fire is, no doubt, the most practical, and will meet the needs of these districts in the most economical manner. It may be that some revenue may be obtained from the power that might be generated. However, this feature has been given no consideration and the economy of this method is based on reducing the time spent in long hauls and unproductive work and the sanitation of the whole locality.

The number of pounds of garbage to be collected has been estimated in the same manner as has the number of loads of rubbish. It has been assumed that various wards having the same character of population and having the same general conditions should collect the same number of pounds of garbage per load. Keeping these facts in mind, the number of pounds of garbage per load to be expected for 1913 has been averaged over these various wards and over the various years. After having estimated the number of pounds per load to be hauled, the number of loads per month is directly obtainable.

Using the time of collection, the rate of haul under varying conditions, the distance to be hauled to the point of disposal, and scale of labor and teams, a standard cost of collection and hauling has been determined, and estimates made [a large detailed table giving many data by wards is omitted, since it is chiefly of local value.—Ed.].

The investigation described above was made by the Chicago Civil Service Commission under the direction of Major James Miles, examiner in charge, and J. L. Jacobs, engineer in charge, F. H. Cenfield and A. B. Segur, Engineers of the Efficiency Division.

Allowance for Evaporation from Reservoir Surfaces

By Gen. H. M. Chittenden*

In a recent investigation of the water-supply capable of being derived, by the aid of storage reservoirs, from a certain watershed, the writer was impressed with what seemed to him the rather careless method adopted by engineers of standing in making allowance for the evaporation from reservoir surfaces. The rule almost invariably adopted is to estimate the gross yield from the watershed including the reservoir area, on the basis of the land run-off and then deduct the assumed evaporation from the reservoir surface. Since the run-off from the reservoir area is 100 per cent. of the rainfall, and from other portions of the watershed only a small fraction of this, the correct method would evidently be to figure the run-off from the watershed exclusive of the reservoir area, add to it the run-off (= rainfall) on the reservoir itself and then deduct the surface evaporation. With the reservoir area very small compared with the watershed area, the error involved in the usual method is relatively quite small, and as it is invariably on the side of safety there is ordinarily no objection to its use. Where, however, water is scarce and supplies are figured somewhat to a nicety, it seems worth while to eliminate this error from the estimates. In a case recently considered by the writer the error of the usual method amounted to about 2,000,000 gal. daily, as an annual average. Of course, in actual operation, the error would be eliminated anyway, and the advisability of correcting it in the estimates depends upon the accuracy with which it is desired to compute them.

For the purpose of expressing these relations in algebraic terms

Let A represent the area of any watershed, including reservoir area.

Let a represent the reservoir area in the same square unit.

Let R represent the average depth of rainfall on the watershed for any period in lineal units.

Let r represent the average depth of run-off assumed for the watershed for the same period.

Let E represent the assumed depth of evaporation for the same period.

Then the algebraic expressions for the yield from the watershed by the two methods will be as follows:

(1) $Ar - aE$

(2) $(A - a)r + a(R - E) = Ar - aE + a(R - r)$

As $a(R - r)$ is always positive, (1) is always less than (2) by the value of this third term.

The first form of (2) given above illustrates one of the common phenomena of nature. It is manifest that the larger a is compared with A, and the larger E is compared with R the smaller will be the value of (2) and that it may actually be negative. Take, for example, the great natural reservoir, Lake Superior, whose area (a) is very nearly $0.4A$. In the dry hot term of later summer when R is small and r relatively smaller still, and E ordinarily much greater than R, the first term of the expression may become very small and the second term negative and very large, so that the algebraic sum may be a negative quantity. In fact this is what actually happens. As is well known, the surface of this great reservoir falls in mid-summer with a rapidity which cannot be accounted for by the discharge at its outlet.

It is scarcely necessary to point out that, in localities where evaporation and rainfall are practically equal, evaporation from the reservoir surface may be left out of consideration, provided the reservoir area is excluded from the run-off estimates; also that the reservoir area will be a source of loss whenever E is greater than R, and a source of gain whenever it is less.

An anticipated criticism in regard to r will be considered. It may be said that r should represent the average run-off, taking into consideration the 100% run-off on the reservoir area. If this were done, then expression (1) would give a correct result. But it is scarcely ever done, r being always assumed as the land run-off unaffected by the reservoir area.

*President Port of Seattle Commissioners, Central Building, Seattle, Wash.

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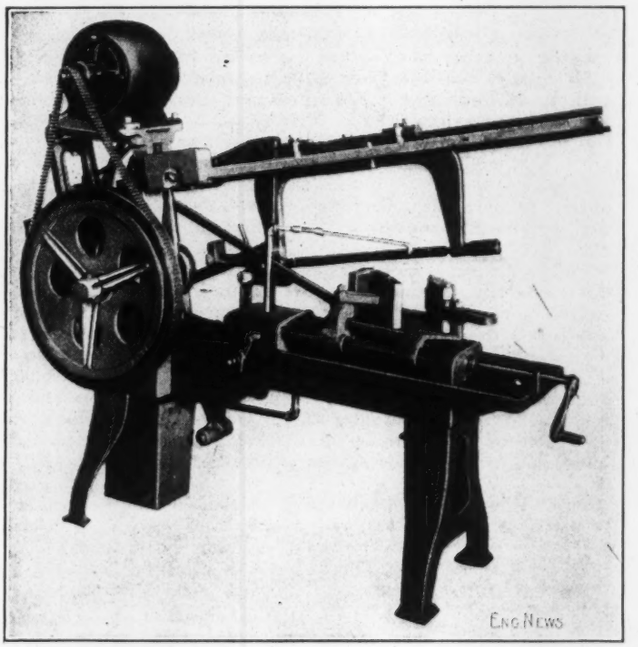
A High-Speed Hacksaw Driven by Electric Motor

The power hacksaw shown in the accompanying cut is so constructed that the length of stroke is automatically adjusted by the size of the stock being cut, so that practically the entire blade is in service at each stroke. An



An Improved Type of Power Hacksaw

automatic lubricating system, a gage for limiting the depth of cut, a swivel vise for angle cutting, and a device for raising the saw blade on the back stroke are some of the special features of this machine.

A Crocker-Wheeler ½-hp., 220-volt, direct-current motor, with variable speed control, drives the saw through a chain belt and gears. The motor speed is capable of variation from 550 to 1100 r.p.m., giving a speed variation of from 50 to 100 strokes per min. for the saw. The saw is made by E. E. Atkins & Co., of Indianapolis.

Maintenance Engineering in Railroad Work*

The chief enemy of the maintenance engineer is water in some form or other. Drainage should not be forgotten in the early stages of an engineering work. Do not dip a road to get under a railway, or a railway to get under a road, without some thought as to the possibility of draining the depression proposed.

In dealing with steel bridge floors there are three courses open to the designer: (1) To make the floor as open as possible, with no place for water to lodge, and every facility for its getting away quickly; (2) to protect the steelwork floor so thoroughly that water cannot get to it; (3) a compromise course. Even the worst drained bridge, however, does not suffer so much as one over a railway, with a floor so designed that steam and gases from locomotives cannot escape freely.

When a structure fails, it is important that a correct diagnosis should be made. Otherwise the treatment may be all wrong, and may lead to large expenditure, when something quite simple and inexpensive would have met the evil equally well.

One instance is recalled where an intelligent inspector, climbing among the girders of a viaduct 140 ft. high, found that there were signs of movement where the girders rested on the piers. The first thing to find out was whether the girders were moving on the pier, or the pier moving under the girders; and observations extending over some time were necessary to settle this point. There was then no doubt that it was the pier that was moving, and getting increasingly out of plumb. Fortunately, the next pier was an unusually massive one, and it was possible with a system of tie rods attached near the base of it to get hold of the faulty pier near the top, and entirely stop the movement. From the date of the first observations to the tightening up of the tie rods, there had been a movement of 1¼ in.

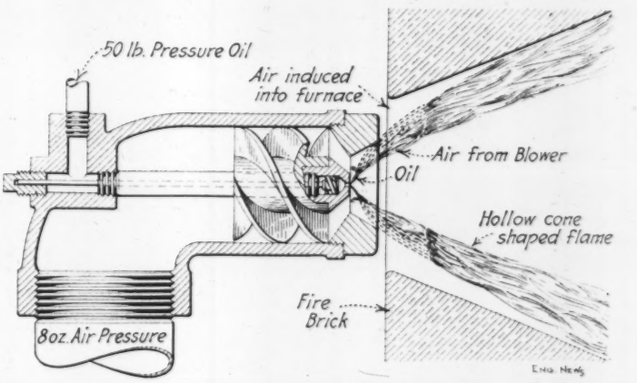
Similarly, if one is called upon to deal with an abutment which is bulging and out of plumb, the first thing to find out is, to what the failure is due; is it, for instance, the result of (1) bad foundations? (2) of colliery workings (and old workings which nobody knows much about are sometimes very troublesome)? (3) of excessive pressure from swelling clay or defective drainage behind? or (4) of imperfect building and want of proper bond, or sufficient section in the wall itself? The treatment will entirely depend on the diagnosis. For instance, it would simply be waste of money to rebuild or reface if colliery workings were the cause of the trouble, unless indeed the settlement due to them had quite ceased.

In the design of new works the consideration of the likelihood of future alteration has a bearing on the materials to be used. If it is likely to come soon, one does not build with the same solidity adopted if the structure is to be one of real permanence. In designing bridge work, some of our predecessors in days gone by have added large margins to the calculated strengths of their structures, remembering the effect of corrosion and the tendency to increase the weights of locomotives, etc. We are now reaping the benefit of this liberal policy; for had things been calculated more closely, our maintenance expenditure would now be largely increased.

*Abstract of article in the "Journal" of the Junior Institution of Engineers, London, England, by A. Clifford Swales, Secretary.

A Design of Fuel-Oil Burner Atomizing Oil at High Pressure with Air Under Low Pressure

The design of fuel-oil burner shown in the accompanying figure has been arranged in an attempt to increase the efficiency of oil combustion for boiler and metallurgical furnaces. A characteristic of many low-pressure oil burners has been their ineffective atomization of the oil and a consequent low combustion efficiency. Therefore recourse has usually been made to high-pressure air or steam for atomizing, but the general difficulty which seems to have been encountered here lies in the difficulty



A Fuel-oil Burner Using Oil at High Pressure and Air at Low Pressure
(Designed by H. B. Stilz, Philadelphia).

of thorough mixture of the oil particles with the proper amount of air on account of the high velocity of the former.

This design shown comprises an inner nozzle through which oil is forced at 50 lb. pressure. At the end of the passageway in this nozzle is a small orifice and within the passage is placed a spindle bearing a spiral fin, which is claimed to cause the oil on delivery to rotate and spread out in a cone-shaped film. Around the inner nozzle above mentioned is a casing through which air passes, and within this casing is a larger spindle also with a spiral fin, which it is claimed gives the air a whirling motion as it passes out. By the velocity of the air in a radial direction from the burner axis, a certain amount of suction seems to be produced which draws the oil particles into the current of air. This, it is claimed, results in the desired intimate mixture and atomization. The shape of the issuing flame is controlled by the shape of the bell mouth of the outer orifice.

It is reported that competitive tests, conducted in 1912, at the plant of the Link Belt Co. in Nicetown, Pa., showed that this type of burner required only some 31% of the amount of fuel of high-pressure burners in use. Sizes have been made to give a capacity range of from under 1 gal. of oil per hour to over 400.

This design is the work of H. B. Stilz, 1938 N. Marvine St., Philadelphia, Penn., from whom this information has been obtained. The device is protected by broad patent claims.

A butter-tub cover lodged in a sewer pipe joint at Hutchinson, Kan., according to reports, and cut off the flow of sewage as completely as if it had been a valve placed there for the purpose.

Suggested Salary Schedule for New York City Engineering Employees

The Board of Estimate and Apportionment of New York City, which has final decision on all appropriations in the city budget, recently appointed a committee of its members to standardize the salaries of positions in the municipal civil service. As the city has several thousand engineering employees this committee requested the society, known as The Municipal Engineers of the City of New York, composed of about 600 engineers in the city service, representing 22 departments or bureaus, to suggest a uniform classification of grades and a schedule of salaries for each grade.

The society delegated this work to a committee of its prominent members. The committee has given the subject several months of deliberation and has just rendered its final report, which has been tabled until the February meeting, for further discussion. From the results of the discussion at the meeting of the society held Dec. 23, there appears to be a division of opinion which will test the fundamental objects of the society as a professional organization.

An abstract of the report submitted by the society's committee, for transmission to the Board of Estimate and Apportionment, is as follows:

EXISTING SALARY SCHEDULES

The positions in the New York City engineering service are at present graded according to limits of salaries; the limits are fixed as follows, the amount given in each case being the minimum salary for the grade:

Grade	A,	$300	per annum
"	B,	600	" "
"	C,	1200	" "
"	D,	1800	" "
"	E,	2400	" "

Practically, grades A and B are useless, for no engineering positions are paid so small a salary as $600.

For the inspection service, the grades are as follows:

Grade	1,	$900	per annum
"	2,	1200	" "
"	3,	1500	" "
"	4,	1800	" "
"	5,	2100	" "
"	6,	3000	" "

Here "grade" is really used to comprise in each instance a group of grades. This is a somewhat perverted use of the word, and has led to or permitted the numerous irregular salaries found upon the city payrolls.

Appointments from open competitive lists, as well as from promotion lists, are made to positions of the same title at different rates of compensation and in different grades in the various departments, for work of the same market value. Unnecessary promotion examinations are thus required, due to arbitrary and illogical grading.

SUGGESTED NEW SALARY SCHEDULE

REVISED NOMENCLATURE—The first recommendation is a suitable nomenclature, as a means for adequately expressing the suggestions as to standardization of salaries and grades. In the following definitions an endeavor has been made to conform closely to present practice of the Municipal Civil Service Commission.

CLASS—A distinction based partly on method of appointment and partly on general nature of service rendered; there are four classes: Exempt, Competitive, Noncompetitive and Labor.

TITLE—The name of a rank or of a position, as Rodman, Inspector, Engineer, Draftsman, Mechanical Engineer, Chief Engineer.

RATING—The mark or the order of standing on a list resulting from an examination.

POSITION—A place or office in an organization having certain duties or functions, determined by those in authority; there may be one, a few or many of a kind in an organization. Position is solely an organization unit. A position may have different salaries from time to time, that is, the incumbent may be in different grades. For example, a young man may be put in a position of responsibility, in a minimum grade, but with increased value of services due to experience and greater efficiency may be advanced to a higher grade, while still performing the same set of duties. Positions should be designated by titles, as brief as practicable, suggesting clearly the functions or duties of the employee, for example: Rodman, Electrical Engineer, Designer, Section Engineer, Deputy Chief Engineer; wherever practicable these titles should coincide with those of the civil service ranks.

RANK—A term indicating in a general way the relative importance of various kinds of positions, but not necessarily descriptive of the special duties of a position of the given kind in a specific organization; for example: Axeman, Rodman, Draftsman, Assistant Engineer, Engineer.

GRADE—A distinction governed only by annual rate of salary. There are two or more grades in each rank, but for each grade only one salary, fixed and uniform for all departments and bureaus. The grades are numbered consecutively from the lowest to the highest, in one series.

GROUP—A set of grades within which advancement is without examination. For promotion from one group to a higher group or for entrance to a group an examination is required. In some ranks there is but one group, and consequently no group designation is needed; in ranks demanding more, the groups are designated A, B, etc., in ascending order.

DEPARTMENT—For the purposes of this report only, includes "bureau," "board," "commission" and other similar divisions of the city government.

PROPOSED RANKS AND GRADES—In standardizing the engineering and other branches of the city service, sharp distinction must be made between organization, which covers the selecting and arranging of the number, titles and rates of pay for the various positions required by the different departments, and grading of the positions by ranks and salaries for purposes of municipal accounting and civil service regulation. No recommendations are made in detail along the lines of organization. Recommendations are made for grading positions in the engineering and inspection services under titles and rates of pay; for general rules to be applied to entrance, advancement in salary and promotion in said services; and for a method making the standardized schedule effective. Simplicity in civil service classification and grading is most desirable, for administrative, economical and moral reasons. To this end ranks and grades should be few.

A grade will always indicate a definite salary, whatever the employee's title, in all branches of the service.

This continuous numbering of grades indicates clearly the relative money values put upon different kinds of service and makes plainer an employee's steady advancement in compensation as he progresses in experience and fitness.

Positions such as architect, chemist, bacteriologist and others requiring technical knowledge, of each of which there are a small number, shall be subject to the same grouping, grading and rules governing advancement as are Rodman, Instrumentman, Assistant Engineer and Engineer.

The maximum salaries for Instrumentman, Draftsman and Junior Engineer, are identical, and employees in any of these ranks are eligible to the rank of Assistant Engineer, but only upon passing the proper examination, and after necessary length of service.

The minimum rate of advancement is intended to be as indicated in the above table from Grade 1 to and including Grade 9. It is intended to assure steady progress, certain conditions having been satisfied, pursuant to a general resolution or similar action of the appointing power, covering routine cases. This plan should simplify procedure, especially in the larger organizations, and should give the employee a more denite basis of expectation as to his income. Many private concerns have a similar practice.

This completes the suggested schedule of salaries, but the committee went further and recommended rules and

SUGGESTED STANDARD GRADES FOR SALARIES UP TO $5000 PER ANNUM

(For all ranks)

Grade	1	2	3	4	5	6	7	8	9	10	Increment.
Salary	$750	$900	$1 050	$1 200	$1 350	$1 500	$1 650	$1 800	$1 950	$2 100	$150
Grade	11	12	13	14	15	16	17				Increment.
Salary	$2 400	$2 700	$3 000	$3 500	$4 000	$4 500	$5 000				$300 and 500

SUGGESTED SCHEDULE OF SALARIES AND GRADES FOR THE ENGINEERING SERVICE

Rank and Group	Grade	Salary.
Axeman	1	$750 first year
	2	900 second and subsequent years.
Rodman	3	$1 050 first year
	4	1 200 second and subsequent years.
Instrumentman	5	$1 350 first year
	6	1 500 second year
	7	1 650 third and fourth years
	8	1 800 fifth and sixth years
	9	1 950 seventh and subsequent years
Junior Draftsman	3	$1 050 first year
	4	1 200 second and subsequent years.
Draftsman	5	$1 350 first year
	6	1 500 second year
	7	1 650 third and fourth years
	8	1 800 fifth and sixth years
	9	1 950 seventh and subsequent years.
Chief Draftsman	10	$2 100
	11	2 400
Junior Engineer	5	$1 350 first year
	6	1 500 second year
	7	1 650 third and fourth years
	8	1 800 fifth and sixth years
	9	1 950 seventh and subsequent years.
Assistant Engineer	10	$2 100
	11	2 400
	12	2 700
Engineer. Group A	13	$3 000
	14	3 500
	15	4 000
	16	4 500
	17	5 000
Engineer. Group B	Ungraded.	$6 000 and upward.

SUGGESTED STANDARD SCHEDULE FOR INSPECTORS ON ENGINEERING WORK

Rank and Group	Grade	Annual Salary	
Inspector	3	$1 050	Increase at the end of the second year
Group A	4	1 200	in this group to Grade 4.
Group B	5	$1 350	Increase at the end of third year in
	6	1 500	this group to Grade 6.
Group C	7	$1 650	Increase at the end of third year in
	8	1 800	this group to Grade 8; increase at
	9	1 950	the end of sixth year to Grade 9.
Chief Inspector	10	$2 100	
	11	2 400	
	12	2 700	
	13	3 000	

regulations to govern appointments and promotion. These rules apply to engineering grades not in the inspection service and provide that all appointments below the rank of engineer shall be made at the minimum grade for each position; advancement in salary shall be made according to length of service, subject to a satisfactory service record; advancement shall be made only after a year's service in the next lower grade, but exception is made where there is a vacancy in the higher grade; promotion examinations are to be held at stated intervals and any employee of the lower rank may enter irrespective of his length of service, but shall not be eligible for promotion until after at least six months' service in the lower rank; positions in the higher ranks are to be filled so far as possible by promotion; below grade 11 open competitive examinations are to be combined with promotion examinations, but persons on the promotion list shall have preference for appointment over those on the competitive list; for ranks above grade 12 the competitive examination for original appointment shall consist of two parts, the first part to be of general character and limited to engineering principles, while the second part shall be directed to the work of the department in which the vacancy exists, and only those passing the first part shall be eligible for the second part, the rating of the second part to be the final rating; candidates for promotion shall be required to pass only the second part of the examination and their rating shall be the mean of that obtained in the examination and that deemed by the Civil Service Commission to represent their experience and efficiency as shown by their civil-service record and the reports of their superior engineer officers; preferred lists for other departments need not be used when promotion lists are available by the department in which the vacancy occurs unless requested by the appointing power; service in any grade beyond the term fixed for that grade shall be so construed as to give the employee the same privilege for advancement as if the service had been rendered in the next higher grade or grades. For ungraded positions no further examination should be held or only special examination to meet the special requirements of the case.

The committee recommends a wider range of choice from the eligible lists for the higher grades; for grade 13 and higher the choice should be extended to include any one of the five highest on the eligible list. The certified eligible lists should be so classified as to indicate the men having special fitness along certain branches of engineering.

Discussion.—Those who spoke in opposition to this report at the meeting on Dec. 23, claimed that the proposed schedule of salaries has a lower maximum for the positions of instrumentman, draftsman and junior engineer than those prevailing under the present schedule; that the adoption of the proposed schedule would in effect produce a 15% reduction in the highest salaries of these positions, whereas this was an opportunity to recommend a general increase in salaries. The older, more experienced and higher salaried members of the society, who largely composed the committee, believed that the proposed schedule is the fairest to the profession as a whole. They have endeavored to equalize grades and salaries for the same kind of service, with the least possible injury to individuals, though some hardship of this kind is inevitable; and at the same time keep the total expenditure of the city for its engineering services. approximately the same.

The committee believes the question is one which involves the dignity of the society and of the engineering profession, and are opposed to making a direct application for a higher rate of compensation for the lower positions than is already the average for those positions.

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Road Funds from Motor Vehicles in Massachusetts—For the fiscal year ending the first of December, there were registered in Massachusetts upward of 60,000 motor vehicles, including cars, trucks and cycles, and their estimated value is over $90,000,000. In the taxation of these cars the sum yielded was over $1,500,000. The fees paid by the motor-car owners amounted to $614,665 and the fines were $29,108. This makes a total of $2,143,773 that motor-vehicle owners have paid toward state and municipal expenses. How much of the taxes has been used for road work there is no means of determining, but the $643,773 paid in fees and fines all goes to the purposes of the State Highway Commission, and after the expenses of the automobile department are paid is used on the roads.

The figures for the fiscal year just ended show an increase of about 29% in the number of automobiles that have been registered over last year, the actual increase is 11,225 cars. The increase in revenue from fees and fines is $139,580. There were registered 50,132 cars, which represent as nearly as can be estimated the actual number of machines used in the state. Included in the total car registrations were 4040 commercial vehicles, the increase in these being almost 100%.

The preponderance of the small car is interesting, fully 40% of all the cars registered being in the 20- to 30-hp. division, where the fee is $10 per car. Only about 25% of all the cars registered were above 30 hp. The small number of very high-powered machines is striking, only about 1% of the total being cars of 50 hp. and above. About 8% of the registrations were commercial motor vehicles. There are 66,546 persons licensed to drive automobiles, or nearly one motorist to every 50 of the state's entire population.—[Boston "Evening Transcript"].

Stone Crushing and Screening, Fairmount, Ill.

By K. E. Casparis*

SYNOPSIS—Plants for the production of crushed stone have had a notable development in this country, owing to the very great demand for such material for blast-furnace flux, concrete, road making, railway ballasting etc. Two features of this development are (1) the great capacity of the crushers in regard to size of stone handled (thus reducing the labor and cost of quarry work), and (2) the extensive use of machinery and mechanical appliances to reduce the labor cost and labor troubles of the entire plant. The article given below describes a plant which produces stone for blast-furnace and cement-mill use exclusively. The crushers are of the roll type, and skips (automatically loaded) deliver the crushed stone to the sizing screens. The plant presents a number of special features in its mechanical equipment. Descriptions of large stone-crushing plants and large crushers of the gyratory, roll and jaw types will be found in Engineering News *of June 4, 1908, Oct. 21, 1909, Jan. 12, 1911, and Feb. 22, 1912.*

The quarry of the Casparis Stone Co., at Fairmount, Ill., has always been operated exclusively for furnishing limestone to the United States Steel Corporation, to be used as flux in the furnaces of the Illinois Steel Co. and the Indiana Steel Co. at South Chicago, Ill., Joliet, Ill., and Gary, Ind.; and also for mixing with slag at the mills of the Universal Portland Cement Co., at Buffington, Ind. The material consists of a high-grade calcite.

Operations started in 1898. At that time the crushing plant was equipped with a No. 6 Gates breaker, which was soon after replaced by a No. 7½. The latter continued in service until 1904, when a new plant, including a No. 9 Gates breaker, was installed. This has been operated continuously both day and night, until the present year. The No. 9 plant is equipped with hoists, continuous bucket elevator, screens, etc., such as are commonly installed for similar purposes. The present plant, described in this article, is installed with a view to securing the best possible operating efficiency not only in the crushing operations themselves, but also in enabling larger blocks to be handled in the quarry and the quarrying costs thereby reduced. This plant was put in operation during 1912.

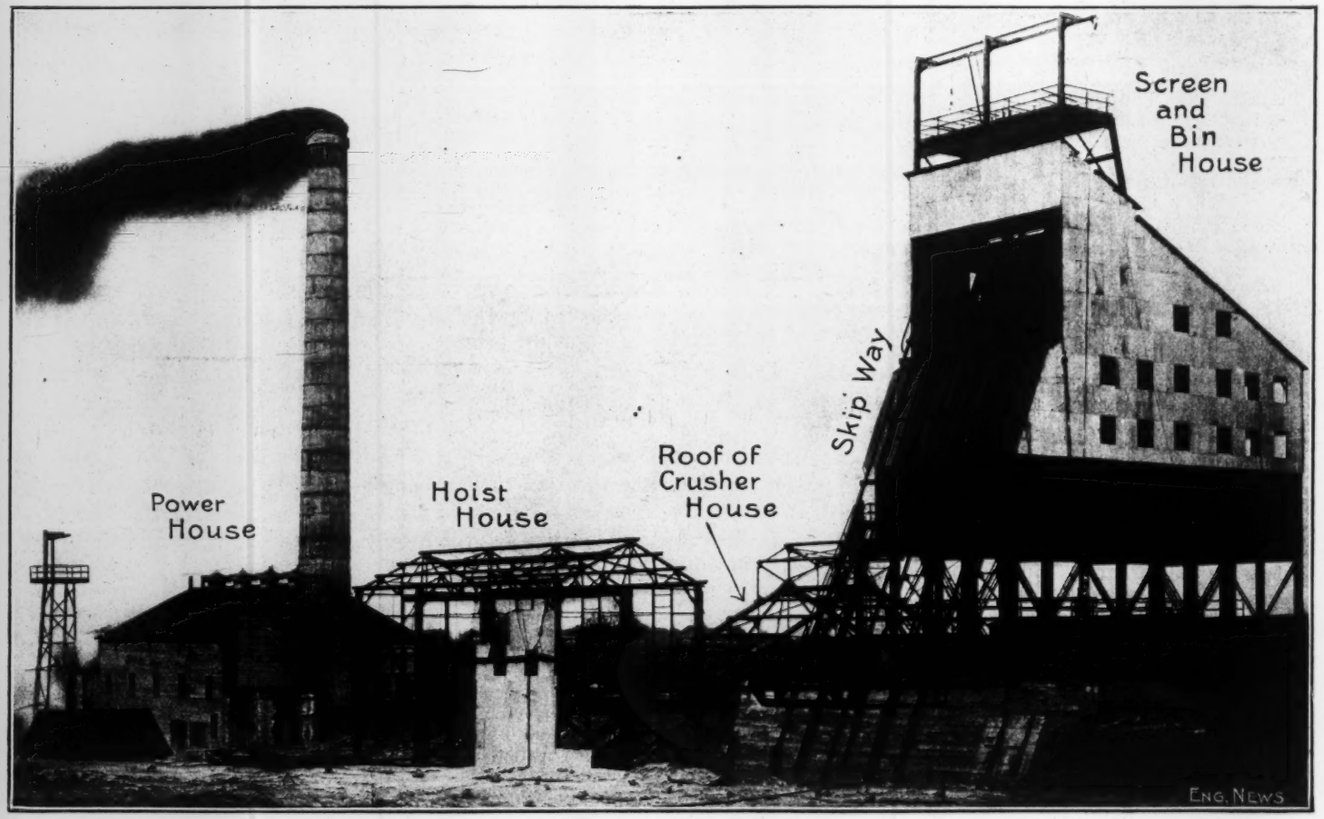

Fig. 1. Stone Crushing and Screening Plant (with Roll Crushers) at Fairmount, Ill.
(Casparis Stone Co., Columbus, Ohio, owner.)

Quarry Work and Plant

The deposit of calcite has an average thickness of only 20 ft., and it is covered with about 12 ft. of earth. Stripping is done with steam shovels. The unusual depth of the overburden as compared with the thickness of deposit makes it especially important to reduce cost at this point, and everything possible has been done to that end. The shovels used are of the Marion type,

*Assistant General Manager, Casparis Stone Co., Columbus, Ohio.

ranging in size from 60 to 100 tons. All strippings are dumped back into that part of the quarry from which the stone has been taken, the material being conveyed away for this purpose by 6 and 8 yd. side-dump cars hauled by light locomotives.

In drilling operations, the deep-well method has been applied. The blasting is done in single trains, with electric firing. The shattered stone is loaded with steam shovels of the type above mentioned. It is occasionally necessary to reduce large pieces of rock by "dobeying." During cold weather it is found difficult by ordinary means to prevent the dynamite from freezing, and W. O. Taylor, Vice-President and General Manager of the

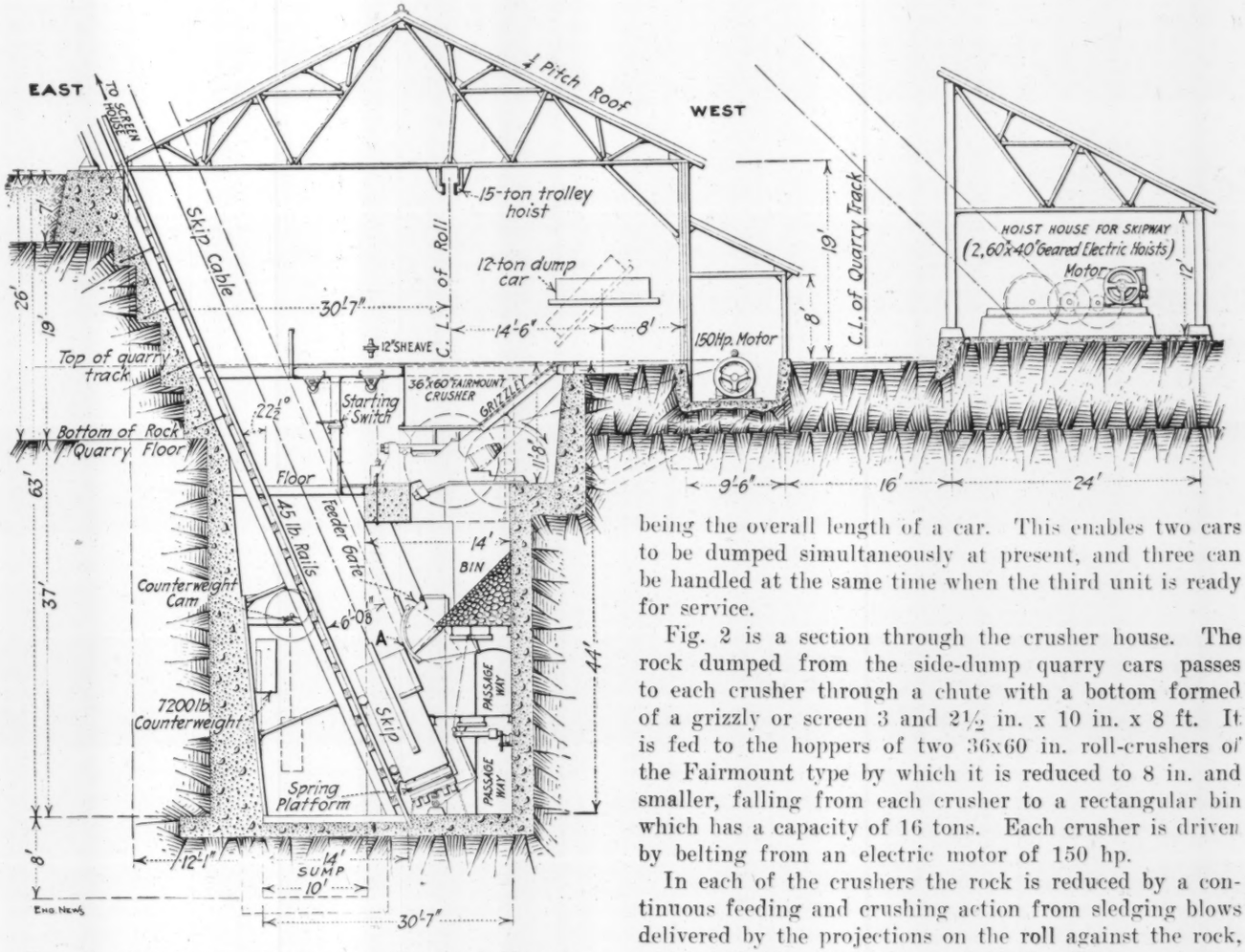

FIG. 2. CROSS-SECTION THROUGH CRUSHER HOUSE; SHOWING ROLL CRUSHERS, SKIPWAY TO SCREEN HOUSE, AND HOISTING PLANT FOR OPERATING THE SKIPWAY CABLES

Casparis Stone Co., conceived the idea of making a dynamite carrier on the principle of the "thermos" bottle. With each of these he succeeded in keeping the dynamite 24 hr. without freezing, even when the weather got to 20° below zero. The use of the new carrier proved, in fact, so successful that a separate company has been formed to take over its manufacture and sale.

The stone is loaded in 8-yd. (12-ton) side-dump cars, eight of which are coupled in a train and hauled distances varying from 500 to 5000 ft. to the new crushing plant by 35-ton Vulcan locomotives. The haul is approximately on level track. At the crushing plant the arrangements have been so made that cars can come in from either direction or can be run through the plant.

NEW CRUSHING PLANT

The new plant consists mainly of a crusher house and a screen and bin house, with an inclined skipway from the pit below the crushers to the bin above the screens. At present there are two units, as shown in Fig. 1, but the foundations have been placed for a third set of crushers and the necessary extension of the buildings. The units are spaced 16 ft. 3 in. c. to c., this being the overall length of a car. This enables two cars to be dumped simultaneously at present, and three can be handled at the same time when the third unit is ready for service.

Fig. 2 is a section through the crusher house. The rock dumped from the side-dump quarry cars passes to each crusher through a chute with a bottom formed of a grizzly or screen 3 and 2½ in. x 10 in. x 8 ft. It is fed to the hoppers of two 36x60 in. roll-crushers of the Fairmount type by which it is reduced to 8 in. and smaller, falling from each crusher to a rectangular bin which has a capacity of 16 tons. Each crusher is driven by belting from an electric motor of 150 hp.

In each of the crushers the rock is reduced by a continuous feeding and crushing action from sledging blows delivered by the projections on the roll against the rock, which is held against the anvil block. These successive continuous crushing blows produce a gripping action upon the smaller pieces of rock in the charge delivered to the crusher, crushing them by pressure with a clean sharp break. Each piece drops lower on the anvil block, following each blow, until it leaves the machine. After the smaller pieces in the charge of rock delivered to the crusher have been crushed and passed through the machine, the large pieces (which are automatically rejected until the last) are first sledged and turned over to present new surfaces for crushing until they are broken into sizes small enough for the gripping, crushing action mentioned.

The operation of crushing has the effect of clearing the crusher from fine material before the large pieces add their quota of crushed material to the product. This

avoids choking and effects a uniform feed of crushed material delivered by the machine. The action also has a further advantage. Thus, should any pieces be sent to the machine too large to be crushed, the tendency of the operation of the machine is to clear the hopper of the remaining rock in the charge delivered to the crusher so as to make it a simple and easy matter to remove or turn over the very large pieces of rock. In this way it is not necessary to dig out the entire charge, as may be the case with jaw and gyratory crushers.

Handling the Crushed Stone

The capacity of these crushers and the large amount of stone to be handled opened an entirely new problem in the stone-crushing industry. The Casparis Co. being unwilling to adopt in a plant of this magnitude the old methods of handling stone, suggested the use of skips. The problem of thus handling stone in a practical and economical manner was solved by the Allis-Chalmers Co.'s engineers in an original manner. Each

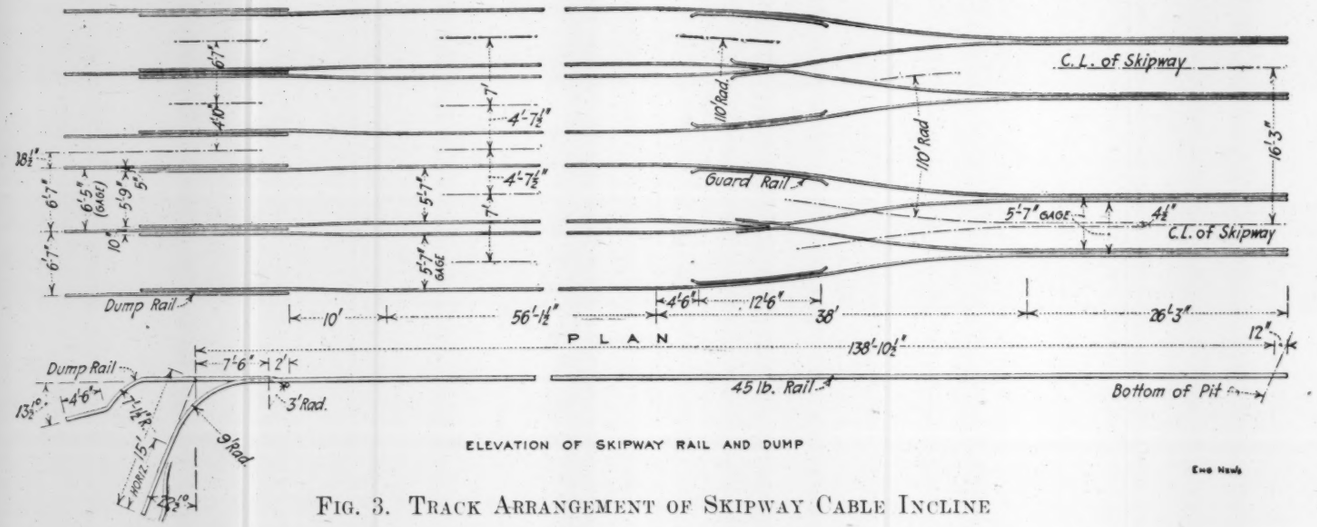

Fig. 3. Track Arrangement of Skipway Cable Incline

pit or bin into which the crushed rock is discharged opens towards a skipway inclined away from the crushers at an angle of 22½° from the vertical. The stone from each crusher is elevated by two skips operated by cable and working in balance, except for the weight of the material being hoisted.

Each skip in its descent to the loading position (Fig. 2) engages a latch *A* on the bin gate, causing it to open downward. The gate, however, is so proportioned that no stone is discharged into the skip until the latter has reached its proper loading position. The bin gate is held open by the weight of the skip until there has been discharged into it from the bin its normal load of eight tons of crushed stone.

During the time that the skip receives its load it rests against a spring-supported platform at the bottom of the skipway. This platform serves a double purpose: 1, it absorbs the shock of the descending skip, and 2, when the skip is started the springs exert an upward pressure upon it momentarily, thus greatly assisting in the starting of the hoist motor. The plant is so designed that the latch holding the bin gate can be automatically tripped by raising the counterweight attached to the spring platform, or it may be manually released by an operator pulling on a rope.

As the descending skip approaches the bottom of its travel, the loaded skip approaches the top of its travel, and both skips are stopped simultaneously. The stopping of the hoist which operates the two skips is effected by means of a standard traveling-limit switch, connected to the drum shaft of the hoist. This is so designed that near the end of the travel the proper amount of resistance is exerted to slow down the motor, and, at a predetermined position, the solenoid-operated main line switches are opened by breaking the circuit through the traveling-limit switch.

This switch has as its principal movable element a nut traveling in guides, this nut being directed in its travel by the rotation of a screw. The screw rotates in opposite directions with the reversals of the hoist, causing the nut to travel in opposite directions, thereby stopping the skips at each of the predetermined limits of travel. When the skip at the bottom of the incline has received its proper load of stone from the bin, the latch holding the bin gate open is tripped, allowing the gate to be closed by its counterweight. During the last movement of the bin gate, just before closing, a clip on the cable of the counterweight engages with an electric switch which starts the hoist. After the skip has reached the limit of its travel, the hoist is stopped by the traveling-limit switch, and the above operation is repeated for the alternate skip as soon as it has been filled with stone.

There is one hoist and a pair of skips for each crusher. Each hoist is driven by a 125-hp. three-phase, 60-cycle, 550-volt, induction motor, which is geared to the hoist and fitted with solenoid brakes. The motor runs at 560 r.p.m., and the hoist has a rope speed of 200 ft. per min., equivalent to about 13 r.p.m. for the drum shaft. Fig. 3 shows the arrangement of the skipway tracks, and the lower and upper ends of the skipway are shown in Figs. 2 and 4 respectively. It will be seen by Fig. 3 that each skipway has two sets of rails forming separate gantletted tracks with centers 4½ in. apart, the track gage being 5 ft. 7 in. In approaching the top of the incline the tracks swing apart by curves of 110 ft. radius and are then parallel, with centers 7 ft. apart. At the head of the incline the track rails become horizontal, and on these run the front wheels of the skip. The rear wheels have double treads, and at this point

the outer (smaller) treads engage with inclined dump-rails, up which they ride; in this way the skip is tilted and discharges its contents into the bin. This is shown in Fig. 4.

When the special electric switch above the bin gate is actuated by the closing of the gate, a secondary circuit is closed which energizes the solenoid of the main-line reversing switches to the hoist when these switches close, current is admitted to the motor and at the same time the solenoid attached to the brake is energized, thereby releasing the brake. The hoist motor is of the wound-motor type, with slip rings and variable resistance. The closing of the contactors which automatically cut out resistance is at first prevented by the heavy rush of current action on a series relay. As the motor accelerates and the current value decreases, each step of resistance is automatically cut out, there being five steps in all. As the nut on the limit switch, referred to above, approaches one end of its travel it first open the hoist are provided at each end of the travel of the nut above mentioned. The control switches at both ends are closed except when the nut is in its final position at one end or the other. Current, however, can only be admitted to one side of the main-line reversing

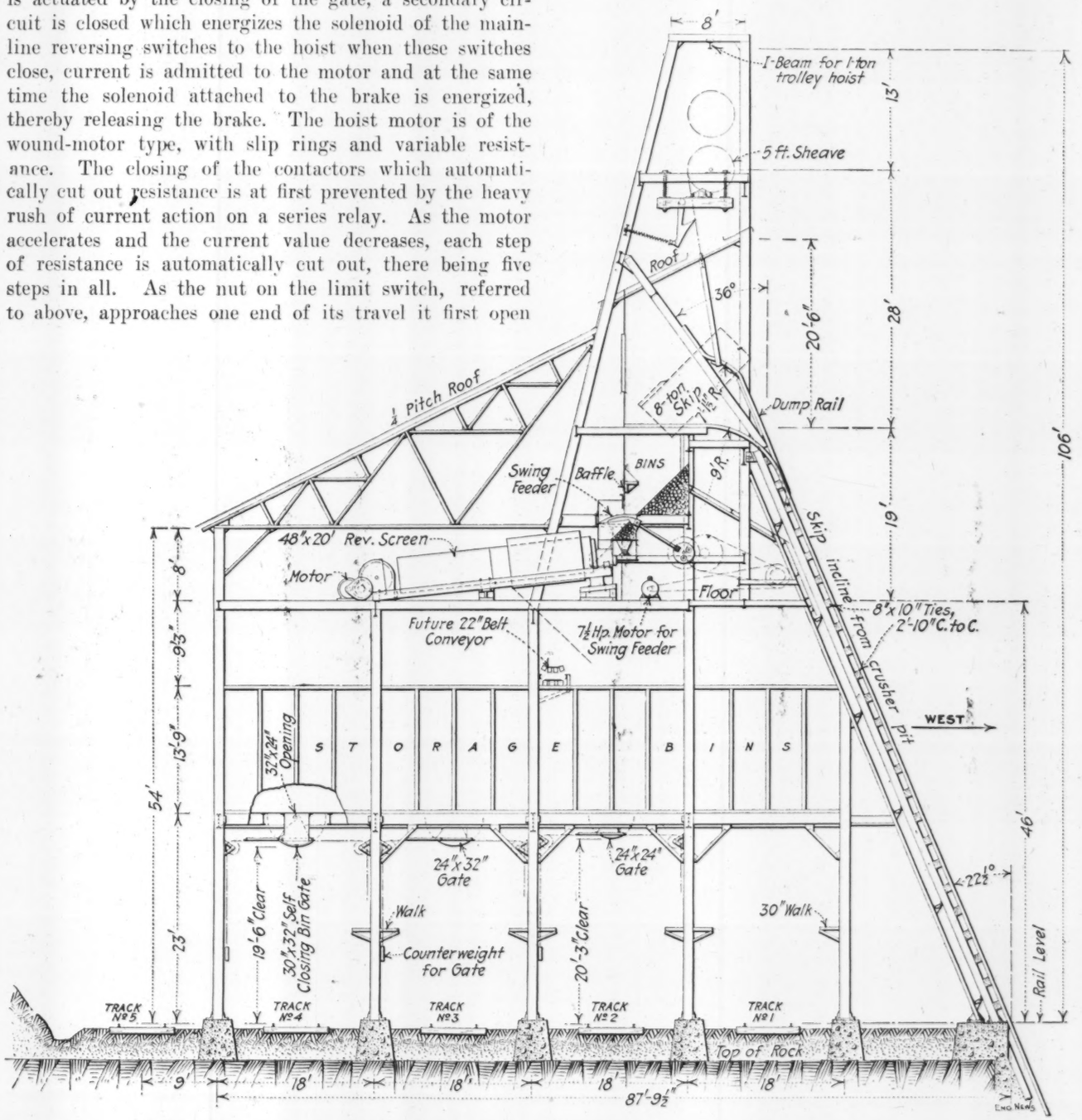

FIG. 4. CROSS-SECTION THROUGH SCREEN HOUSE; SHOWING SKIPWAY, SCREENS AND STORAGE BINS

a secondary contact which causes all the resistance switches to open, thereby throwing full resistance into the circuit of the rotor of the hoist motor.

In actual practice this switch opens when the switch is about 10 ft. below its dumping position. Due to the resistance inserted in the rotor circuit, the hoist slows down and is stopped at a predetermined position by the opening of a second switch (finger contact). One switch for cutting in resistance and one switch for stopping switches through the special control reversing switch which is operated by the closing of the bin gate.

SCREENS AND STORAGE BINS

At the top of the skipway the crushed stone is discharged to bins with an aggregate capacity of 120 tons, as shown in Fig. 4. From these it is fed through Gates automatic swing feeders to four 4x20-ft. revolving screens, inclined 1½ in. per foot. Each screen with its charge of

stone weighs about 15 tons. These screens separate the material into 1½ in. to 5 in., and oversize (which last is 8 in.). The 1½-in. and finer stone goes to the portland cement mills. The material from 1½ in. to 5 in. is used for flux in the blast furnaces. The oversize stone is used in open-hearth furnaces, and a part of it is sent to the cement plant, where it is crushed in No. 6 Gates crushers. At certain seasons of the year the dust must be screened from the 1½-in. size in order to prevent the material from freezing in the cars.

From the trommels or screens the stone falls directly into bins for the different sizes. These bins are of the box type, the stone forming its own hopper. The bin gates are of the radial opening pattern, made exceptionally large and heavy on account of the size of product to be discharged. Railway cars are run underneath the bins on four tracks, a fifth track being provided as a run-around for bringing in empty cars. The total weight of stone when all the bins are level full is about 1200 tons, taking the weight of the stone at 100 lb. per cu.ft.

The power plant consists of four Heine water-tube boilers and one 600-kw. Parsons turbine-alternator, with steam and motor-driven exciters. The plant was designed and machinery furnished by the Allis-Chalmers Co., of Milwaukee, Wis.; and the structural steel work was designed and furnished by the North Works (Chicago) of the Illinois Steel Co. The plant was erected and started under the supervision of the writer.

The Assets of Iowa Cities early in 1912, according to the fifth annual report of the State Department of Finance and Municipal Accounts, totaled $21,825,702. Divided into 13 groups [and rearranged from greatest to least] these assets were as follows:

Water-works	$7,851,314
City parks	3,770,141
City libraries	2,758,931
Bridges	1,917,010
Municipal buildings and land	1,557,813
Fire department, land, buildings, apparatus, etc.	1,339,833
City electric-light works	1,170,286
Cemeteries	441,706
Equipment of streets and alleys	319,882
Hospitals, docks, wharves, etc.	277,501
Police department buildings, apparatus and other property	196,904
Furniture and fixtures	135,877
Markets and public scales	94,514

A 100-Ton Coal Car: Norfolk & Western Ry.

A radical development in freight-car design and capacity has been made recently by the Norfolk & Western Ry. in introducing a coal car of the enormous capacity of 90 tons and equipped with a special design of six-wheel trucks to distribute the load and keep the wheel loads within limits. While the nominal capacity is 90 tons, the car is designed to carry 10% overload, and on an experimental trip it has actually carried 200,600 lb. of Pocahontas coal. A view of the car is shown in Fig. 1, while the general construction design of the car and its trucks is shown in Fig. 2. Cars of such capacity could be used economically, of course, only in some special service, and this car was designed with special reference to operation between the Pocahontas coal-fields and the Lambert's Point deep-water terminal of the Norfolk & Western Ry., near Norfolk, Va., where the car would be handled by a car-dumping machine.

FIG. 1. COAL CAR OF 100-TONS CARRYING CAPACITY, WITH SIX-WHEEL TRUCKS; NORFOLK & WESTERN RY.
(John A. Pilcher, Mechanical Engineer. W. H. Lewis, Superintendent of Motive Power.)

100-TON COAL CAR: NORFOLK & WESTERN RY.

Length over end sills	46 ft. 10¾ in.
Width over top angles of sides	10 ft. 4½ in.
Height of top angles from rails	10 ft. 4½ in.
Length inside	45 ft. 6¼ in.
Width inside	9 ft. 6 in.
Depth inside	6 ft. 6½ in.
Distance between truck centers	32 ft. 10 in.
Truck wheelbase	9 ft. 0 in.
Wheels, diameter	2 ft. 9 in.
Weight, body	35,400 lb.
Weight, two trucks	29,800 lb.
Weight, total	65,200 lb.
Capacity, nominal	180,000 lb.
Capacity, actual (10% overload)	200,000 lb.
Cubic capacity, level full	2,829 cu.ft.
Cubic capacity, heaped 30°	3,380 cu.ft.

The car is of the flat-bottom gondola type, with drop doors. The sides form plate-girders and the center sill or girder is composed of two heavy channels. The general dimensions and weights are given in the accompanying table, but it is expected that the weights of both the body and the trucks can be reduced by revision of the designs after experience with this first car. The truck is of special design, known as the Lewis truck, and is a six-wheel truck without pedestals. The wheels are of

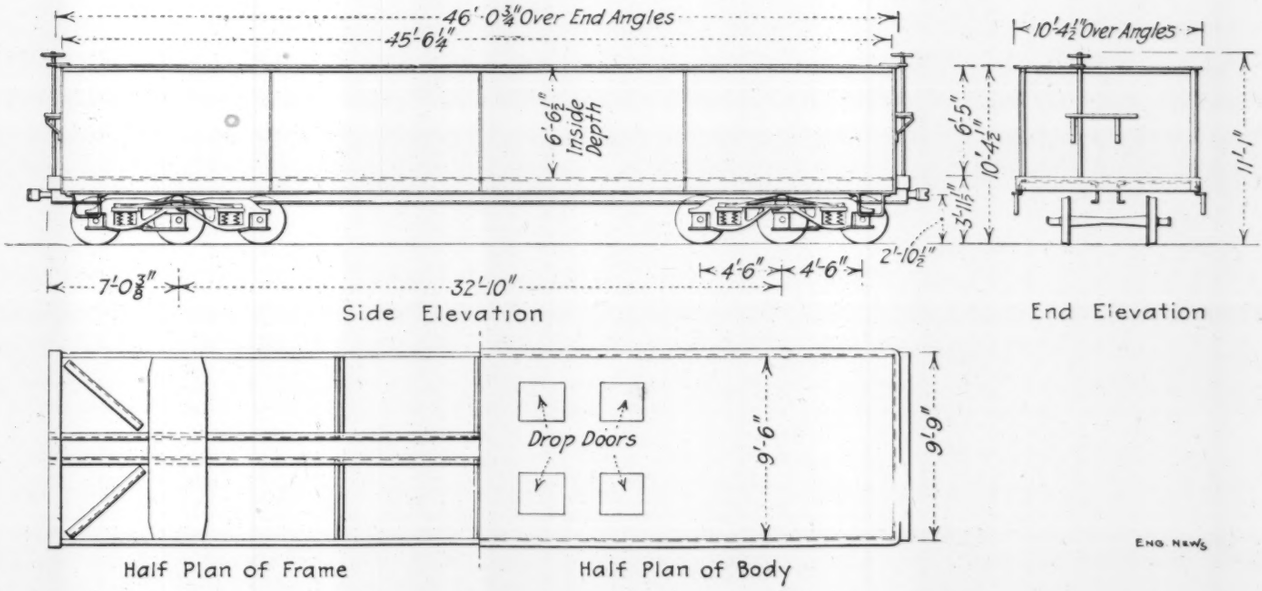

FIG. 2. GENERAL DESIGN OF 100-TON COAL CAR; NORFOLK & WESTERN RY.

forged steel. The frame is articulated over the middle axle-box, which arrangement allows ample movement of the axles to take care of any vertical irregularities in the track. This is clearly shown in Fig. 3, in which the cast-steel beam which carries the side-bearing has been removed from its seats on the bolsters (over the nests of springs). The springs are so located that the side frames themselves become equalizers and properly distribute the loads between the wheels. When carrying the load of 200,600 lb., mentioned above, the axle loads were 44,300 lb.

A patent for this truck has been granted to two of the officials of the mechanical department of the Norfolk & Western Ry.; John A. Pilcher, Mechanical Engineer, and W. H. Lewis, Superintendent of Motive Power. For photographs and other information we are indebted to Mr. Lewis.

Daily Fluctuations in Sewage Flows was the subject of a brief paper submitted to the Institution of Civil Engineers by William Fairley (Vol. clxxxix. Session 1911-1912. Part iii). Flows were observed for districts having populations ranging from 650 to 65,000, and per capita water consumptions varying from about 15 to 37 U. S. gal. per day. The author, after having presented a series of diagrams and explanatory text, summarized his conclusions regarding both the effect of subsoil water and the differences between day and night flow as follows:

> From the foregoing remarks it would appear that, while the quantity of subsoil water finding access to a system of sewers has a certain effect, still, if not excessive, it does not materially alter the fluctuation in flow. This fluctuation is directly proportional to the length of outfall sewer and the ruling gradients of the sewers of the district. The flatter the gradients and the longer the outfall sewer the higher will be the percentage of night flow, and the more equal will be the flow during the 24 hours, the difference between the minimum and maximum rates of flow being reduced.
>
> In a rural district where the points of contribution are widely scattered, the night flow may not fall below 50% of the maximum rate of flow.
>
> Generally speaking, in an urban district with no exceptional length of outfall sewer and fair gradients in the collecting sewers, the night flow will be about one-third of the maximum rate of flow.

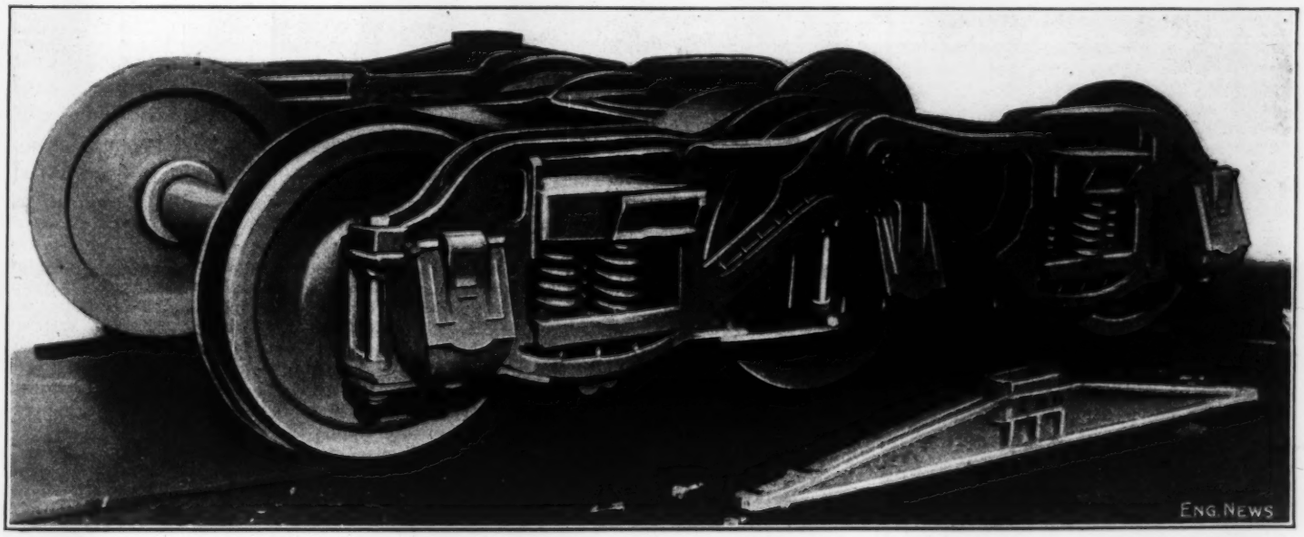

FIG. 3. SIX-WHEEL TRUCK WITH ARTICULATED FRAMES (AND NO PEDESTALS), FOR 100-TON COAL CAR; NORFOLK & WESTERN RY.

(The cast-steel beam carrying the side bearing has been removed to show the frame articulation. When in place this rests on the seats at the ends of the bolsters, over the springs.)

The Design and Specifications for the Arrowrock Dam, U. S. Reclamation Service

In our issue of June 6, 1912, p. 1062, we published an extensive article by C. H. Paul, Construction Engineer, U. S. Reclamation Service, describing the Arrowrock Dam project. Since that article was published the Reclamation Service has issued the specifications (Specifications No. 224) under which the dam had been designed and is to be constructed. As this is to be the highest masonry dam in the world, a description of it is necessarily interesting, but aside from this distinguishing feature there are others which make it especially notable. Among these are the methods of construction by force account, the use of sand-cement, the use of vertical contraction joints in the dam's structure, and the precautions taken to observe any leakage under the dam after construction. We give below portions of the specifications and some of the drawings showing the design of the dam. Readers are referred to the previously noted article for views and drawings of the dam site as well as for information regarding the preparatory work there.

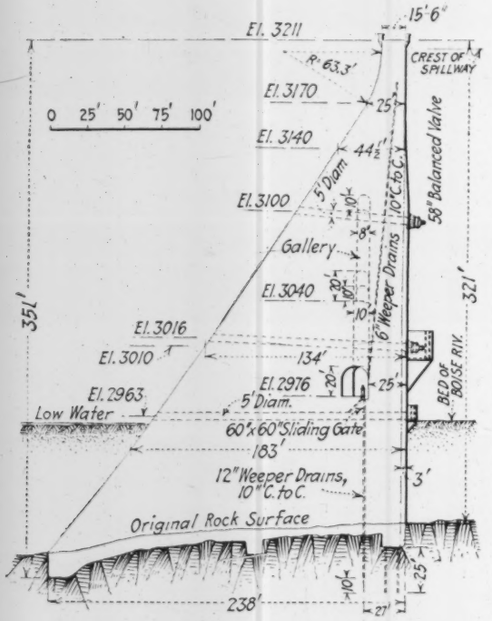

FIG. 1. TYPICAL SECTION

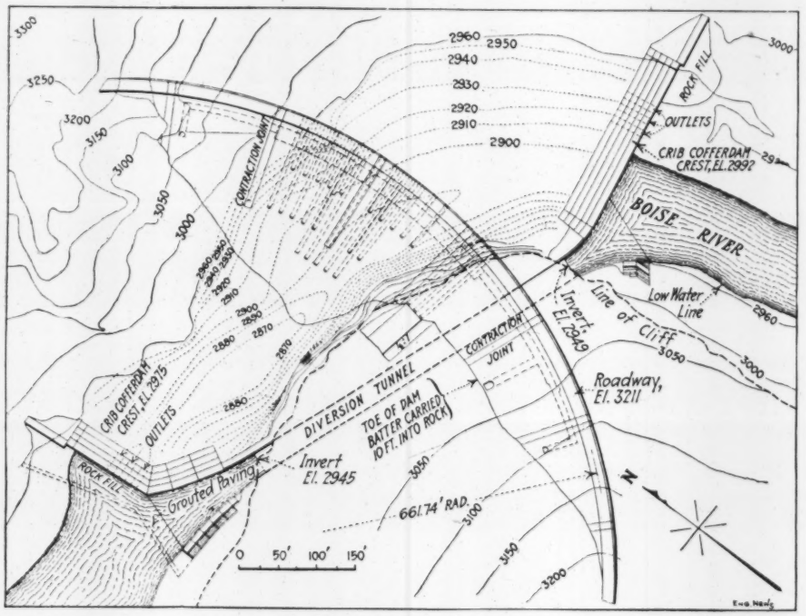

FIG. 2. PLAN

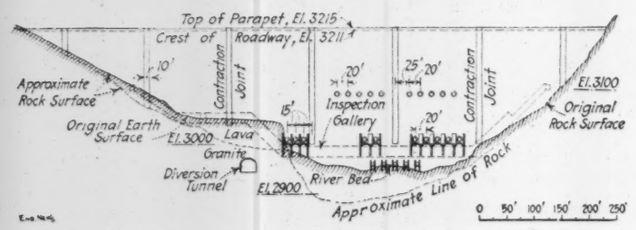

FIG. 3. DEVELOPED FRONT ELEVATION

FIGS. 1-3. DETAILS OF THE ARROWROCK DAM, U. S. RECLAMATION SERVICE

The work is to be done on force account by the Reclamation Service. It will be noted that the peculiarity of the method of organization is that the government engineers are divided into two forces—a construction force, which corresponds to the contractor, and an engineering force, which corresponds to the engineer on ordinary contract work. The paragraphs of the specification describing the work are as follows:

The Arrowrock Dam will store water in the Arrowrock reservoir for the Boise project of the U. S. Reclamation Service. It will be located in the cañon of the Boise River, about 20 miles above the city of Boise, Idaho. The dam project consists of one 350-ft. masonry dam with a concrete masonry spillway. The dam will be of the gravity type, curved in plan, and will be built of concrete. It will be about 1050 ft. long on top, and its maximum height will be about 350 ft. above the deepest part of the excavation. The lowest portion of the foundation will be about 80 to 90 ft. below the present bed of the river. The spillway will consist of a concrete weir about 400 ft. long, discharging into a channel, to be cut into the hillside. This channel will convey the water around the north end of the dam and will discharge into Deer Creek below. The diversion works will consist of two crib coffer-dams across the Boise River and a tunnel about 490 ft. long, with a cross-sectional area of about 670 sq.ft., and a capacity of about 20,000 sec.ft.

ORGANIZATION OF CONSTRUCTION FORCE

The Director of the Reclamation Service, through the supervising and construction engineers and superintendent of construction, will purchase all materials, equipment and supplies and will employ all labor necessary for the construction and completion of the dam and its appurtenant features. A scale of wages shall be fixed from time to time by the supervising engineer, after having received suitable written recommendations covering such scale of wages from the construction engineer and superintendent of construction. The supervising engineer shall divide the organization as would be done if the work were to be performed by contract, into the engineering division, under the direction of the construction engineer, and the construction division, under the direction of the superintendent of construction.

The duties of the engineering division shall be similar to those of the engineering force on contract work; the principal duties of this division being to make estimates and designs for the works and to see that the works are built in accordance with the plans and specifications, and this division will be held strictly responsible for this feature of the work. This division shall also give the construction division such help as may be necessary in getting out designs and estimates

for the construction plant. For the purpose of executing his duties, the construction engineer shall organize office and field engineering corps that shall report directly to him. All work, other than clerical, in connection with the construction, maintenance and operation of the Arrowrock R.R. [a government road built for purposes of construction], the power house at the Boise River Diversion Dam and the transmission line leading therefrom to Arrowrock shall be under the charge of the construction engineer.

The duties of the construction division shall be similar to those of the construction force on contract work; the principal duties of this division being to provide methods and plans for actually executing and building the works and to construct the work. This division will be held particularly responsible for the progress and cost of the work. In any work on designs and estimates for the construction plant that, under contract work, would be done by the contractor's engineering forces, the construction division shall be assisted as much as may be necessary by the engineering division. The superintendent of construction shall select his foremen and principal assistants, who shall report to him, and he will be held responsible for the efficiency of the entire construction force. He shall detail one man as cost keeper, who shall obtain from the clerical and engineering forces all data necessary for compiling the reqired reports of costs. At the end of each calendar month the cost keeper shall furnish the construction engineer (with a copy to the supervising engineer) a detailed statement, certified by the superintendent of construction of all costs, including estimated apportionment of general expenses, depreciation, unit costs of work done, etc.

The supervising engineer's office at Boise shall handle all advertisements, purchases and vouchers covering materials and supplies for use in the construction of the dam, and the chief clerk of the supervising engineer's office shall be responsible for all clerical work. He shall conduct the clerical work in such a manner as to relieve the engineering and construction divisions from the necessity of occupying their time with clerical matters. Pay rolls shall be made up in the supervising engineer's office, based on time books certified by the superintendent of construction and transmitted from Arrowrock, and the fiscal agent at Boise will pay all employees, including those receiving time checks.

Cement

A sand-cement, made up of approximately one-half portland cement and one-half sand ground together, will be used in the main section of the dam. Portland cement will be used in the minor works around the dam. The specifications in this regard read as follows:

Upon the delivery of portland cement at the dam site, it shall be reground with granite or other suitable material to form sand-cement, which shall be used throughout the dam, spillway weir and lining, in the same manner as portland cement, unless otherwise specifically ordered by the engineer. The term "sand-cement" signifies the product of regrinding portland cement with suitable blending material in proportions fixed by the chief engineer, and these proportions shall be one part sand to one part cement by weight unless otherwise directed.

Design of Dam Section

Fig. 1 herewith shows the cross-section of the dam; Fig. 2 a plan, and Fig. 3, a developed front elevation. All necessary dimensions are noted on the drawings, so they will not be referred to in the text. It should be observed that the design is a normal gravity type, and is extraordinary only in its height. There are, however, two novel features provided: (1) An inspection gallery (Fig. 3) running through the whole section and providing opportunity for inspection of possible leakage, and (2) the contraction joints, which are provided in the section at intervals of about 150 ft. The contraction joints are made normal to the dam faces and are formed against vertical transverse bulkheads. Each face is coated with acceptable materials to prevent adhesion to the masonry on the other side of the joint. In order to minimize contraction, the concrete in these joints is to be placed in cold weather, February or March.

Foundations

The excavation for the dam is described in the specifications as follows:

The material in the river channel consists mainly of river sand, gravel and boulders, and constitutes the greater part of the material to be excavated for dam foundation. On the south side of the river, the excavation will consist of stripping the dam site of a shallow covering of loose material and cutting suitable foundation in the rock. The work on the north abutment will consist mainly of removing a mass of seamy rock and large boulders embedded in loose rock and loam, and of cutting a suitable foundation in the ledge rock. Rock shall be excavated to a sufficient depth to secure a foundation on sound ledge rock free from open seams or other objectionable defects. It is the intention to build the masonry against the sides of these rock excavations.

After the rock foundation for the dam has been prepared all further work on said foundation shall be designated as special preparations of rock foundation of dam. This special preparation shall be measured and estimated under the following classes: (1) Areas receiving special preparations. Portions or the whole of the foundation of the dam may be designated for special preparation and in all areas thus designated for special preparation and in all areas thus designated seams and cavities shall be traced as far as directed by the engineer by drilling holes or by other improved means. All such seams and cavities shall then be filled with concrete, mortar or grout. Whenever directed by the engineer, grout shall be pumped under pressures required by him through hose or pipe of at least 2 in. in diameter. (2) Pressure grouting and drilling drainage holes and main grout holes. In addition to the drilling and pressure grouting that may be required as noted in the previous paragraph, grout and drainage holes shall be drilled as shown on the drawing or as directed by the engineer, and after a portion of the masonry in the dam has been placed, grout under suitable pressure shall be pumped into the grout holes as directed by the engineer.

Concrete for Dam

The specifications read:

It is planned to build the main body of the dam of concrete consisting of about 1 part sand-cement, 2½ parts sand, 5 parts gravel and 3 or 4 parts cobblestones, in which large rock and boulders of various sizes will be embedded. These proportions may be varied to suit conditions.

In this designation cobblestones are considered as sound, clean gravel or broken rock of such size as will pass a grizzly having bars set about 6 in. apart, and be retained on a grizzly having bars set 3 in. apart. . . . Embedded rock is defined as follows: In all mass concrete having a thickness of 15 in. or more, sound and clean cobblestones or rock fragments of a size that can be lifted and handled by one man, shall be incorporated in the concrete. The proportion of such rocks shall be as nearly uniform throughout as practicable. No rock shall be laid in actual contact with an adjacent one or within 2 in. of the forms. In the main body of the dam, there shall be placed hard, sound, clean and durable rocks of derrick size, carefully shaken to position in fresh beds of concrete. Whenever possible, smaller rocks shall be embedded in the concrete between the large rocks. The object is to obtain, especially in the main body of the dam, a monolithic mass of stone and concrete containing as large a proportion of rock and as impervious to water as it is practicable to secure.

Forms

It should be noted that the specifications say: "All exposed faces of concrete work shall be molded against steel forms, or, if timber forms are used, against lagging that has been sized to uniform thickness and placed so as to prevent leaking of the fluid concrete."

Other Features of the Project

In addition to the dam there are to be constructed a spillway, a tunnel, and two coffer-dams. The spillway consists of a spillway weir about 400 ft. long over which the waste water spills into a spillway trench, made by excavating and lining a trench with reinforced concrete. The coffer-dam consists of timber cribs filled with loam, sand, gravel and rock. The diversion tunnel is located in

rock for its entire length, and is to be lined with concrete on the bottom and sides and with timber above the springing lines of the arch.

PERSONNEL

The present personnel of the engineering forces is as follows: F. H. Newell, Director, U. S. Reclamation Service; A. P. Davis, Chief Engineer, U. S. Reclamation Service; F. E. Weymouth, Supervising Engineer, Arrowrock Dam, and C. H. Paul, Construction Engineer, Arrowrock Dam.

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Construction Features of the Elephant Butte Dam, U. S. Reclamation Service

The U. S. Reclamation Service has issued under date of August, 1912, Specification No. 227 for the construction of the Elephant Butte Dam on the Rio Grande Project, New Mexico-Texas. The following extracts from that specification and the accompanying drawings well illustrate the design and proposed construction of the dam and its allied projects:

General Description—The work to be done under these specifications is the construction by Government forces of a storage dam, and its appurtenant features, across the Rio Grande, at Elephant Butte, New Mexico. This dam, together with a dike about 1¼ miles northwest of the dam, will form a reservoir having a capacity of 2,600,000 acre-ft. The dam will be of gravity type, straight in plan, built of concrete in which will be embedded rough stones of various sizes up to about 4 cu.yd. each.

(a) The section of the dam will be in accordance with Fig. 1.

(b) The top of the dam will be 200 ft. above the original river bed. It will be about 1200 ft. in length, with a roadway along the top.

(c) The faces of the dam below the coping will be of concrete built in place with the use of sectional forms.

Rock Excavation for Foundation—Excavation shall be made to a sufficient depth to secure a foundation on sound ledge rock, free from open seams or other objectionable defects. It is the intention to build the masonry against the side of these rock excavations. To preserve the rock outside the lines of the excavation in the soundest possible condition and to obtain over the whole foundation a rock surface free from open seams or cracks, unusual precautions will be required in excavating. Blasting may be done to the extent directed, with explosives of such moderate power and in such positions as will neither crack nor damage the rock outside of the prescribed limits of the excavation, and whenever, in the opinion of the engineer, further blasting is liable to injure the rock upon or against which the masonry is to be built, the use of explosives shall be discontinued and the excavation of the rock continued by wedging and barring, or other approved methods.

A cutoff trench will be required at the heel for the whole length of the dam. This cutoff trench will have nearly vertical sides.

Preparation of Rock Foundation—The surfaces of the rock foundations shall be left sufficiently rough to bond well with the masonry and shall be cut to rough benches or steps, unless naturally so stepped. Care must be taken not to open or break the ledge rock unnecessarily. Before laying the masonry on or against the ledge rock, the latter shall be scrupulously freed from all dirt, gravel, scale, loose fragments, and other objectionable substances. Streams of water, air or steam under sufficient pressure, stiff brooms, hammers and other effective means shall be used to accomplish this cleaning. Steam jets shall be used to remove thoroughly ice or snow, if any be found on the foundation when it is desired to lay masonry. All springs shall be piped and grouted or carried outside the dam. After cleaning and before concrete is laid on or against the foundation the water shall be removed from the depressions so that the surface can be inspected to determine whether seams or other defects exist.

(a) Small seams and cavities showing on the base and the face of excavation where masonry is to be placed shall be carefully scraped and cleaned out and filled with rich concrete or mortar rammed in under pressure.

(b) All holes that were drilled in river bed at the time when soundings were made to select a location for dam, and that penetrate the actual foundation of the dam, shall be grouted.

(c) In the center of the cutoff trench a row of holes shall be drilled as shown on Fig. 4, which holes shall be grouted after the concrete above shall have been carried up to a convenient elevation not less than 20 ft. above the base of the dam.

(d) Under the longitudinal gallery of the dam two rows of holes shall be drilled as shown in Fig. 4, that will eventually be made to extend up to the floor of this gallery. Care shall be taken in order to prevent any line of weakness between drainage holes to place large rocks in the concrete between them. These holes are meant to act as drainage holes, permitting the water that leaks into them to drain into the gallery. A similar set of holes shall be provided above the gallery, as shown in drawings.

(e) If after the completion of the dam it should prove that the discharge of one or a number of these holes (that terminate in floor of gallery) is excessive and the discharge continues to increase, it may then be proper to close up such holes by pumping into them grout under pressure.

(f) Whenever in excavating the abutments thick strata of shale or similar material liable to decompose on exposure to air are encountered, drifts generally parallel to the axis of the dam shall be driven along these seams until a safe distance from points of possible exposure is reached. These drifts shall be at once thoroughly washed and cleaned and immediately refilled with concrete. Grout should be pumped in especially around the top so as to entirely fill the opening.

Cement—All portland cement shall pass the U. S. Government standard specifications. The same care must be observed in the unloading, storing and safe keeping of this material, and for the return of the full number of sacks to the railroad station in serviceable condition, as would apply on construction under contract. Cement sacks must be carefully handled so that they are not torn or damaged; they must be completely emptied and shaken out and returned to the storehouse to be bundled and shipped back to the factory. Upon the delivery of the portland cement at the dam site, it shall be reground with sandstone or other suitable material to form sand-cement, which shall be used throughout the dam in the same manner as portland cement is ordinarily used. Hereafter in these specifications the term "cement" will signify the product of regrinding portland cement with suitable blending material in the proportions fixed by the chief engineer. All sand-cement shall be inspected and tested before being used in this work.

Concrete in Body of Dam—Concrete shall consist of an intimate mixture of river sand taken from the excavation for the dam, run of crusher rock and cement, in proportions to be determined by frequent mechanical analysis of the ingredients; approximately a 1:3:6 mixture when everything in the crusher run below ¼-in. size is considered as sand, and is added to the river sand to make the three parts. The rock furnished the crusher shall be taken from the sandstone quarries along the railroad, and must be sound, hard and clean.

Concrete Upstream from Drainage Holes—This concrete is to consist of a mixture so carefully proportioned as to have the greatest impermeability possible. The proportions are to be determined by mechanical analysis of the ingredients available and by experiments on samples taken from large batches.

Stones for Masonry—Stones for embedding in concrete shall be sound, free from seams and cracks, clean, hard, of irregular shapes, without long thing projections, and of various sizes up to the largest which can be economically quarried, transported and handled. They shall be thoroughly cleaned before being brought on the dam, by washing with water under pressure from a nozzle, by the use of brushes, or otherwise, and shall be clean when placed in the concrete. Hammers or other tools shall be used, if necessary, to remove objectionable materials adhering to any stone. Stones shall be wet at the time of placing in the work.

Masonry, Placing—Wet concrete in sufficient quantities shall be deposited in low places in the work, and large stones shall be lowered into it immediately as close together as possible, but leaving room to thoroughly fill the spaces between them with concrete. The concrete shall be carried to the work in bottom-dumping buckets, or as otherwise directed. The stones after placing shall be joggled with a bar so as to settle well into the concrete, and the concrete shall be worked with suitable tools to force the escape of entrained air or surplus water, and insure the filling with con-

crete of all spaces around the large stones. In placing large stones, care shall be taken to secure as good bonding, both horizontally and vertically, as practicable with this class of masonry. Wherever convenient, smaller stones shall be embedded in the concrete between the large stones. The object is to obtain a monolithic mass of stone and concrete, containing as large a proportion of stone as economical. Wherever a concrete surface must be left long enough to permit the concrete to set, the surface must be left as rough as possible by means of large rocks partially embedded. No concrete shall be placed in the dam except in the presence of an authorized inspector.

Racking—The top of the masonry under construction shall be kept at all times approximately level between contraction joints or such other limits as required, except that the downstream side shall be generally higher than the upstream side. Pinnacles for landing platforms and similar purposes shall not be built. Where racking is permitted the slopes shall not be steeper than 1 to 1, and the face shall be as irregular as possible. Small spall dams shall be built to prevent the concrete from running down the face of the rack. The trowel work on the spall dams is the only trowel work which will be required or expected in connection with cyclopean masonry. When trowel work is necessary it shall be done with mortar of such consistency as to give a tight joint.

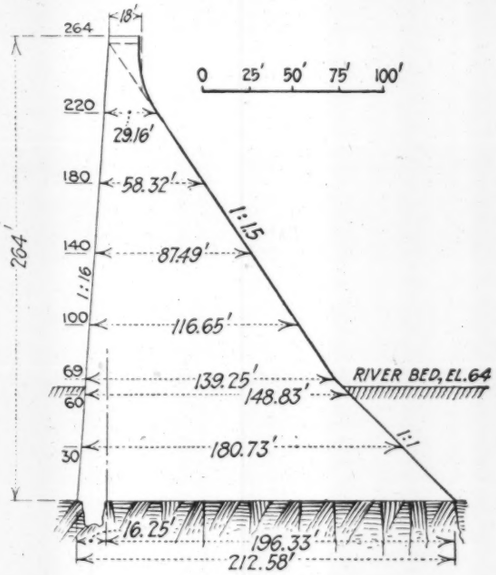


FIG. 1- CROSS-SECTION

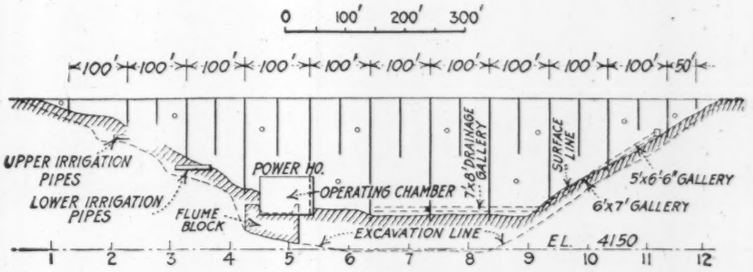
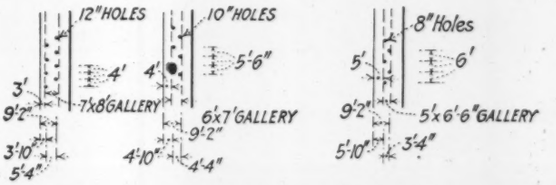


FIG. 2- ELEVATION SHOWING EXPANSION JOINTS



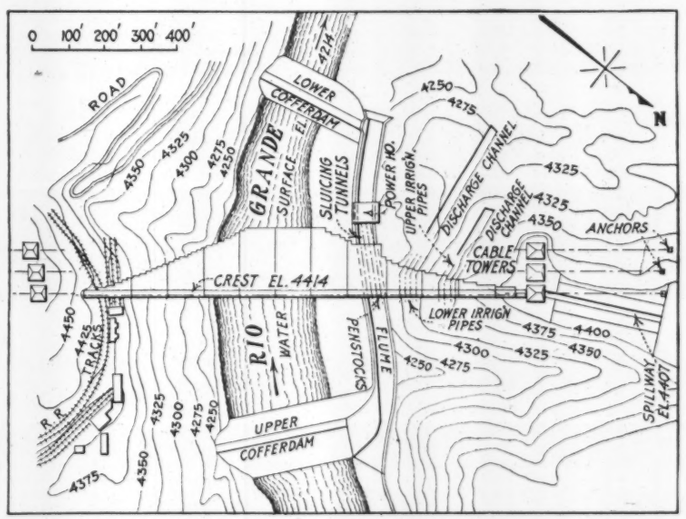


FIG. 3- PLAN OF DAM AND SPILLWAY

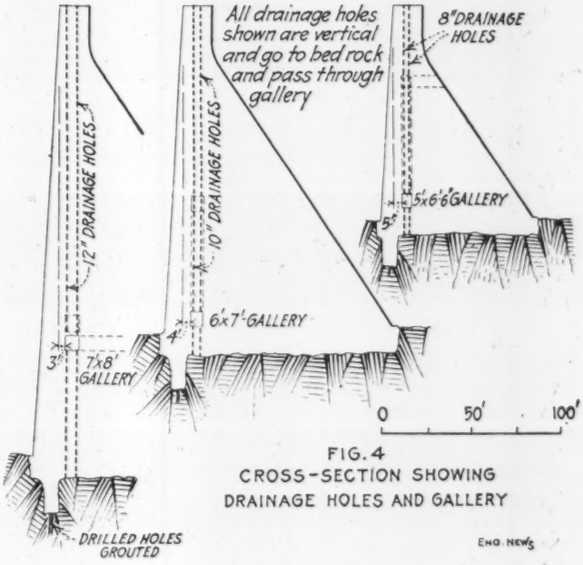


FIG. 4
CROSS-SECTION SHOWING
DRAINAGE HOLES AND GALLERY

THE ELEPHANT BUTTE DAM, U. S. RECLAMATION SERVICE

Contraction Joints—At such intervals and depths as shown in the drawings or directed, contraction joints, normal to the dam axis, shall be formed of masonry built against forms. Each such face shall be coated with acceptable material to prevent adhesion to the masonry on the other side of the joint. The contraction joints will divide the dam into sections, and as the work progresses, alternate sections shall be carried ahead of the intervening ones. Derricks or other hoisting and conveying apparatus may, when the masonry is of acceptable strength, be placed on such higher sections for use in placing masonry in lower sections. One or more of these sections may be maintained at a lower elevation than the adjacent ones, as an additional safeguard against damage by flood.

Filling Vertical Slots—In order to minimize contraction, the sections marked by asterisks on Fig. 3, shall be built in the late winter, preferably in the month of February, and shall never be brought higher than the adjacent sections.

Depositing Masonry under Water—Concrete or other masonry shall be deposited under water only when unavoidable, and extreme care must then be used in its deposition. No water shall be allowed to rise against any masonry until the mortar shall have had at least 24 hours in which to set.

Work in Freezing Weather—When masonry is laid in freezing weather, precautions shall be taken for removing ice and frost from the materials, for protecting the newly laid masonry from freezing, and for heating the materials when necessary to prevent freezing. Covering for the newly laid masonry and such additional appliances and materials as may be required therefor, including steam pipes for keep-

ing the air warm beneath the covering, shall be provided in advance.

Protection of Masonry—Until a sufficient time has elapsed for the setting of the concrete, it will not be permitted to erect derricks or other machinery upon the surfaces of masonry, nor to build centering or forms, nor to land or store stones or other heavy objects, nor to walk or work on such surfaces. Care should be exercised to avoid disturbing stones in any way after they have been set.

Defective Masonry—Masonry damaged by freezing or by alternate freezing and thawing, or from any other cause, or any masonry which shall be found defective at any time before the completion of the dam, shall be removed and rebuilt. Whenever a stone that has been set has its bond broken it shall be taken up and reset.

Protecting Exposed Faces—The facing of the dam and all other masonry which is to be permanently exposed to view shall be effectively protected from injury or disfigurement by the falling of stones, tools, mortar or other objects until the completion of the work.

Masonry to be Kept Moist—Concrete or other masonry shall be kept moist for at least two weeks or until covered.

Grout, Mixing and Using—Apparatus for mixing and placing grout shall be of a type that has been successfully used and shall be equal in efficiency to a machine having for its essential part an air-tight chamber in which the grout is mechanically stirred, and from which it is forced by air pressure into the voids. Whenever it is known in advance that grout is to be used in any place, pipes, through which the grout may be forced, shall be set as the work progresses. In other cases, suitable holes shall be drilled. Holes to test the efficiency of the filling shall be made if necessary. If it is discovered that any voids have not been thoroughly filled by the first application of grout, the process shall be repeated until satisfactory results are obtained.

Special Finish of Concrete Surfaces—Except concrete surfaces for which special finish is required, the exposed faces of copings of wing walls, culverts and other structures, shall have a smooth finish, or by other acceptable means; wherever such surfaces are not cast against forms, they shall be screeded, troweled and rubbed to a smooth finish, by men skilled in such work. Such faces shall be of even texture and color.

Exposed Faces—Care shall be taken to avoid discolorations or marks on surfaces to be exposed to view, and such surfaces as are bounded by angles or grooves, shall be formed by placing concrete continuously until the completion of each such surface. In depositing concrete, the coarse aggregates shall be carefully spaded away from faces to be exposed, except in places for which other directions are given. If any voids or other imperfections are found upon removing the forms, molds or centers, such faults shall be corrected immediately by filling with mortar or otherwise, even to the extent of taking down and replacing unsatisfactory concrete.

Special Surfaces of Forms—In order to secure the smoothest practicable finished surfaces, wherever the concrete is part of a waterway, and elsewhere if required, the centering, if not entirely of metal construction shall be faced with sheet steel not lighter than No. 23 gage, weighing 1.12 lb. per sq.ft., or with other suitable material. The plates shall be carefully selected and shall be put on the forms without wrinkles. The surface of forms, against which concrete is to be deposited, shall be cleaned and coated with soap, mineral oil or other suitable substance to prevent adhesion of the concrete. Where the form is built of separable panels, the sheet metal shall be carried over all straight edges, having been bent to a sharp corner over a straight steel edge. Suitable and effective devices shall be used to hold adjacent edges or ends of panels or other forms tight together and in accurate alignment. Metal covering will not be required on any special forms, which are to be used but once. The surfaces of all such forms, however, shall be tight and smooth. In the waterway they shall produce concrete surfaces equal to those made upon metal forms.

Supports for Forms—Small rods to hold the forms will be allowed in the structures, provided proper means be used to take out a portion of each of the rods nearest the surface at least 2 in. in length. All holes left after removal of the rods shall be filled immediately and completely with cement mortar, and the surface left smooth and in good condition.

Wetting and Placing Forms—Wooden forms shall be wetted thoroughly just before placing concrete, so as to prevent injurious drying of the surface of the concrete by absorption. Where forms are placed in successive units for continuous surfaces, care shall be exercised to fit the forms tightly over completed surfaces so as to prevent leakage from the concrete.

Large-Scale Tests of Plain Sedimentation of Sewage, London, England

Plain sedimentation of sewage instead of chemical precipitation has been tried with promising results at one of the large sewage-treatment plants of the London County Council. The following slightly condensed statement is from a recently revised pamphlet edition of the "Main Drainage of London," by Sir Maurice Fitzmaurice, chief engineer of the London County Council:

The main drainage committee conducted experiments at Barking during the months of May, June, July and August, 1911, with the object of finding out how the effluent would be affected if lime and iron were not added to the sewage, and if some alterations were made in the times and method of cleaning out and removing the sludge from the precipitation channels. The usual interval between the successive cleaning out, or the "channel hours" of any one channel, is 60 hours. A shorter interval, viz., 30 hours, was adopted during these experiments so as to compare with the longer interval usually adopted. The general result of the experiments was that, as regards matters in suspension, almost the same purification was obtained without chemicals by reducing the channel hours to 30, as is at present obtained with the use of chemicals and with 60 channel hours. During the whole period in 1911, while these experiments were being carried on, no complaint was received as regards the condition of the Thames, notwithstanding that the summer of 1911 was exceptionally hot, and the amount of river water coming down was exceptionally small.

The experiments have been continued in the present year (1912) during the months of June, July and August, and the results obtained corroborate generally those obtained in 1911. The Port of London authority takes from time to time samples of the effluent discharged into the river, and during the months the experiments were being carried on they made no complaint as regards the quality of the effluent. In fact, the reports of that authority on the effluent during the experimental periods were of a more satisfactory character than either before or after, when the station was being run in the ordinary way.

The chemicals themselves add considerably to the amount of sludge that has to be dealt with, and it is possible that, owing to chemical combination, the bulk of the sludge may be increased by more than the amount of chemicals used.

If the use of chemicals were altogether discarded a very large saving in working expenses would result. The saving would not, however, amount to as much as the discarded chemicals would have cost, as the expense of increasing the flushing staff so as to reduce the channel hours from 60 to 30 has to be taken into account.

I cannot say exactly what the net saving would be, as the costs of lime and iron vary from year to year, but there is no doubt that, considering both outfall works, it would amount to betwen £15,000 and £20,000 a year [$73,000 to $97,000.—Ed.].

The results of the experiments made in 1911 were given in detail in a report presented to the Main Drainage Committee on Nov. 23, 1911, and the results of the experiments made this year will be presented in a detailed report later on. I am strongly of opinion that one of the outfall works, at all events, should be run completely without chemicals for one year after the termination of the present contracts for chemicals; and from the data thus obtained it may be found advisable ultimately to discard altogether the use of chemicals for precipitation.

❖

A Reduction in Electric-power Rates has been made by the Ontario Hydro-electric Commission to the municipalities which purchase energy through this commission (which supplies them over its own transmission lines from a Niagara Falls plant). The new rates mean a decrease of some $100,000 gross income over the present figures. The total connected load of the system is now about 34,000 hp. It is claimed that the new rates are more than sufficient to cover the various charges together with proper sinking-fund installments. There was a yearly surplus of $62,000 at the end of Oct. 31, which sum is only $10,000 less than the whole sinking-fund charges for the first year. It was not planned to burden the pioneer purchasers of energy with sinking-fund and depreciation charges until the year 1914; but before reducing the rates as above noted, deductions for that purpose were made.

EDITORIALS

A Recent Test of a Flat Slab Floor

At the recent annual convention of the National Association of Cement Users, a paper describing some stress deformation tests on reinforced-concrete flat-slab floors was read by an engineer who has specialized in extensometer measurements on buildings under load. We had hoped from the title of the paper that some further light would be thrown on the subject of flat-slab concrete floors by the tests, and looked forward to publishing the results for the benefit of our readers. On reading the paper, however, we note that while the author undoubtedly has acquired from the tests a considerable knowledge of the behavior of such floor slabs, his published report deals mainly with some general deductions and leaves much to be desired concerning the details of the construction and the test results.

The prevailing ignorance regarding flat-slab design is very great and every test which is made should have the fullest description and the widest publicity, if the profession is to gain the knowledge it needs. This knowledge is particularly needed in the amount of steel to be used in the reinforcing of flat slabs, which amount now varies apparently without reason, and with the taste and fancy of the designer. This particular paper specifically avoids detailed description of the amount of the steel reinforcing in the floors tested, on the very reasonable grounds that the company which designed the building and paid for the tests did not care to give out that information for the benefit of its competitors. One could wish that the company had assumed a broader view of its duty toward the profession, but certainly there can be no quarrel with the attitude it did take. The rights of property are indisputable. But as several correspondents have inquired as to our possible reprinting of the paper, we take this opportunity of explaining why we do not think such reprinting worth while. We have the utmost confidence in the author's analysis of results, but engineers who are interested in flat-slab design want actual figures and full data. Anything less is unsatisfactory.

❖

The Street Cleaning and Garbage Collection Efficiency Studies of the Chicago Civil Service Commission

To be timed by a stop watch in order to determine what percentage of your working day you spend in dodging vehicles must seem like an infraction of both personal and political liberty to a street cleaner under the block or patrol system. Such timing is just what was done in Chicago in 1912 by the engineers of the Efficiency Division of the local Civil Service Commission. Horrible to relate, it is only a small part of what these efficiency engineers did in their efforts to establish standards for street cleaning and for garbage and refuse collection. They studied average speeds of garbage and refuse wagons in going to unloading places and average time taken in loading, besides traffic density, street widths and kinds of pavements being cleaned.

The object of these studies was almost as novel, in city administration, as the studies themselves. It was to secure data on which to base budget estimates and apportionments for the yearly appropriations for street cleaning and for garbage and refuse collection and disposal. Standards were set, not only for the work a man or a team ought to do in a time unit, but also for such things as frequency of cleaning different classes of streets. Knowing these things and the area of streets for street-cleaning work, and the density and character of population for garbage and refuse collection, goes far toward changing the making of appropriations from a guessing game to a scientific procedure—a change doubly needed at Chicago, with its antiquated and politically bad system of making appropriations and administrating work by wards.

Particularly notable is the fact that these studies were made by a civil service commission, and that the Chicago Civil Service Commission has an Efficiency Division, with a staff of engineers, for making just such studies.

Heretofore the work of civil service commissions has been confined almost wholly to (1) the task of seeing that men were selected for employment or promotion with some regard to fitness for the work they were supposed to do, instead of on account of political qualifications; and (2) to seeing that once in office they stayed there until removed by death or physical disability—except in rare cases, when such commissions have taken just action against employees who have indulged in too much political activity.

As a result, the most that civil service has done in the majority of American cities has been to insure security of tenure and promotion by orderly procedure. These achievements are good so far as security of tenure does not result too largely in keeping men in office whether they render poor or good service, nor make promotion a matter of seniority rather than merit.

What has been needed in the civil service has been checks on the efficiency of the men protected by it. While the work outlined above as having been done in Chicago (described in part more fully elsewhere in this issue) appears to have been conceived and executed as a temporary measure for budget-making purposes (an excellent reason, too), those parts of it which apply to human efficiency might well be made a permanent feature of the work of the Chicago and other civil service commissions.

Finally, these unique studies at Chicago deserve to be considered in conjunction with the work-quantity unit-cost budget system, which is to be tried in 1913 for the Borough of Richmond, New York City, described and commented on at some length in our issue of Dec. 26, 1912. The world moves and the engineer is coming into his own.

Limiting the Size of Motor Trucks

The manufacturers of motor vehicles are getting considerably exercised over some proposed state laws regulating the weight and tires of motor trucks. In New York State, for instance, certain of the highway protective interests have suggested a law which will proportion the width of the tire to the load carried and limit the latter. One suggestion provides for an increasing scale starting at vehicles having ½-in. tires to carry a maximum load on one axle of 1200 lb., and rising to those having 10-in. tires, with a maximum load on one axle of 8000 lb., the latter to be the largest loading allowed on any country highway, though no restriction is placed on the loading for city streets.

This proposition is strenuously opposed by the manufacturers, who maintain that such a law is unconstitutional, and that the state is bound to build and to maintain highways for any traffic its citizens want to send over it. Of course, these same manufacturers would never pursue this argument to its absurd limit, but would agree to stop with loads just outside the possible maximum for their own trucks. Manifestly, there must be a limit to the load for which road builders can design. Where is this limit?

The loadings which railway tracks and bridges have to carry are continually increasing, and maintenance men have grumblingly to keep step and to design their permanent structures for the occasional maximum. The economics of railroading demand a certain maximum loading. The owner carefully figures that the gain in revenue from heavier units will more than offset the increased cost not only of those units, but of the roadbed on which they run.

In highway work the problem is quite different. Possibly a 15-ton truck is more economical for some user who only pays the average tax rate for the construction and maintenance for the road on which that truck runs, but is it fair to the thousands of other users who do not benefit by the economies of that large truck to be made to pay the excess cost and maintenance of the roads that that truck requires? The street railway has to pay for the construction and maintenance of the roadway between and contiguous to its tracks. Why should the motor-truck owner get the same privilege free?

The matter has not reached a dangerous stage, for it is probable that the damage to roads by high-speed, high-powered passenger cars is now far greater than any damage which may result from heavy loading. The time is rapidly coming when this will not hold. Witness for instance the 15-ton truck described on the first page of this issue. This truck will carry 20 cu.yd., which may readily mean 20 tons of certain types of material, and there is no doubt that a motor could be designed to draw such a load. This ponderous load moving at a fair rate of speed (8 m. per hr. for the one noted) along a country highway is destructive of the fabric and structure of that highway and its possible crossing of the usual country bridge is a positive menace to life and property. City streets are not designed for any such strain. Anyone who has seen footprints plainly marked on an asphalt pavement during the heat of the summer can readily imagine the effect of a 7-in. tire loaded up to 6, 7 or possibly 10 tons. Certainly the taxpayers of the city are not required to provide a roadway for such a vehicle, merely to benefit the few whose interest is served.

Undoubtedly roads will have to be built from now on with a view to automobile traffic, because the automobile for pleasure and commerce has become a necessity. Doubtless, also, a certain amount of the benefit from the use of the automobile is so distributed that the whole body of taxpayers should shoulder the added cost of the roads it demands. There is, however, a limit where this equable distribution stops and where the added benefit accrues only to certain individuals, and beyond this point those who dance should pay the fiddler. The usual horsepower or cylinder-bore automobile taxes are an attempt to meet this cost, but in the case of the extraordinarily heavy trucks no tax could posibly pay for the increase. Here, then, limitation in weight is the only remedy the state has.

There is a tendency in the opponents of these weight-limit laws to consider them directed against all motor trucks. For instance, a recent editorial in the Boston *Transcript* voices this sentiment as well as the railway analogy fallacy which is noted above:

> When traffic increases on railroads it is the practice of progressive management to build additional trackage and stronger bridges, put on bigger locomotives and cars. The motor truck is a method of merchandise transportation the possibilities of which have scarcely been touched; yet sufficient experience has been gained to show that it has a field of its own and to prove that in the immediate future a vast amount of traffic of this kind will pass over all the main inter-city thoroughfares. And provision must be made for it. The limit of twelve tons for vehicle and load that will be favored by the [Massachusetts State] Highway Commission in a bill would just about admit the five- and six-ton capacity trucks now in common use; it would bar out the heavier trucks such as those of ten tons capacity that are being used elsewhere. That is not a business-like proposition; it is as if the city said to the Boston Elevated: "You cannot carry any more passengers because the subways are not large enough and we don't propose to build any more."

As yet there is no reason to believe that the extraordinarily heavy trucks will prove of great advantage to any but a few users and for the present, at least, it certainly would be inadvisable to levy upon the whole people for the benefit of those few. The problem before the framers of any new law directed against heavy vehicles is to find what is the limit that typical good roads and bridges of today can stand and to prohibit any weight that is in excess. Such a restriction would probably not affect 10% of the motor trucks in use and would certainly not circumscribe their usefulness as a method of transportation.

⁂

Indicting Railway Officials as a Remedy for Accidents

Everyone has heard of the joke of *Punch*, the English comic journal, which proposed many years ago, in the early days of the railway era, that as a safeguard against railway collisions a director of the railway company should be tied to the front of each locomotive.

The joke of half a century ago becomes a serious reality in the United States today, where grand juries in Connecticut and in Indiana have recently returned indictments for manslaughter against the officers of railway companies on account of deaths in two recent railway accidents. In Connecticut the Vice-President and chief operating officers of the New York, New Haven & Hartford R.R. were indicted for the accident at Westport. In Indiana all the directors, the President and all the operating officials of the Cincinnati, Hamilton & Day-

ton R.R. were indicted for a recent wreck on the road where a freight brakeman forgot to close a switch.

It is true, no doubt, that these indictments are brought in response to a public demand that somebody, somewhere shall receive punishment for these accidents, and it is argued in defense of these indictments that they will tend to make railway officers realize more keenly their responsibility for the safety of those whose lives are in their care.

We do not for a moment believe, however, that such extreme measures are needed to impress upon railway officers the measure of their responsibility. At the present day particularly, railway officers everywhere are studying with the greatest care all questions affecting safety in railway operation.

Far from being callous and indifferent to the risk involved in railway operation, it is a fact that among railway officers themselves the percentage of casualty in train wrecks is far higher than with the average traveler. It would be easy to name half a dozen railway accidents within the last 15 years in which Presidents, Vice-Presidents, General Managers, or other chief officers of railway companies have lost their lives. The death of Samuel Spencer, President of the Southern Ry., a few years ago in a rear collision on his own road is, perhaps, the most notable illustration. In fact, railway officers in attaching their private cars to the rear of passenger trains, as is commonly done, are voluntarily doing what *Punch* proposed so many years ago, that is, taking the place of greatest danger.

There can be no doubt, therefore, that railway officers, for the protection of their own lives as well as the lives of millions of passengers and thousands of employees, earnestly desire to do everything possible to attain a high degree of safety in railway operation. To indict for manslaughter, directors, presidents and officials of the operating department whenever an accident occurs on the lines under their charge would give them no keener realization of responsibility than they now have.

It will, of course, be admitted that where definite and direct responsibility for an accident can be traced to an individual, whether he be a brakeman or a railway president, some sound argument may be made in support of an indictment. But what reason or wisdom is there in indicting President Daniel Willard, of the Baltimore & Ohio, because on one of the subsidiary lines of that great system a careless freight brakeman forgot to close a switch after letting his train onto a side-track and so caused the wreck of a passenger train shortly afterward?

If it serves the ends of justice to indict President Willard for manslaughter occurring under such circumstances, we do not see why it would not be equally just to indict President Taft for embezzlement because of a theft of government funds by some subordinate custom-house official.

As many of our readers will doubtless recall, this is not the first time when high officials of a railway have been indicted because of deaths in a train accident. A score of years ago a collision occurred in the Park Ave. tunnel above Grand Central Station in New York City; and in the fire which followed the collision, a dozen or so employees of the car department were burned to death. The directors of the New York, New Haven & Hartford R.R. were indicted afterward on the ground that they had failed to provide their cars with a safe system of steam heating. When the cases came to trial, however, it was found impossible to trace definite responsibility to any of the directors and the suits were dropped. Similar results will doubtless be the eventual outcome in the cases discussed above. Such an ultimate result, however, does not by any means justify the bringing of the indictment in the first place. If the principle were established that railway directors and railway officers were liable to indictment for every accident occurring on the lines under their charge, it would very shortly be impossible to induce competent and responsible men who cared for their reputation to accept such positions. It is of great public importance, however, that just this class of men shall hold these positions. We cannot have safety, and efficiency, and economy in the railway service unless men of this sort are in charge. Let it not be thought either that it is an easy matter to find this sort of men for such positions. Men competent to carry such responsibilities are at a premium everywhere.

Surely the safety of the traveling public will not be increased if we make conditions in the railway business such that the only class of men who will care to hold responsible positions will be those for whom the stain on their personal reputation involved in an indictment in a court of law is a matter of no consequence.

Let it be clearly understood that in what we have said we are not opposing the fixing of responsibility for accidents of any sort and the administering of proper punishment to those found responsible, not as a matter of public revenge, but as a stimulus to others to use greater care in future. What we do protest against is the misuse of the machinery of justice to appease public clamor, led on by sensational journalism, that "some man higher up" shall be sacrificed.

Far Reaching Decision Respecting the Use of the Chicago Drainage Canal

The denial by the Secretary of War of the application of the Sanitary District of Chicago for authority to withdraw 10,000 cu.ft. per sec. from Lake Michigan in place of the 4167 ft. authorized by a previous Secretary, which we print in full elsewhere in this issue, seems to leave Chicago only two alternatives. Either it must fight the question out in Congress, and if successful there, which is very doubtful, it must then fight it out again in a probable arbitration proceeding between the United States and Canada, with possibilities of a fight with navigation and other interests in the courts as well. Otherwise Chicago must, at an early date, begin the construction of a plant to purify its sewage, at least partially, before discharging it into the drainage canal, and this plant must eventually become one of the largest sewage-treatment plants in the world.

The necessity for purifying its sewage arises not alone from the doubt whether the city will be permitted to permanently divert from Lake Michigan even the amount of water it is now taking, but because the towns and cities along the course of the Illinois River will be apt to begin litigation if Chicago sends its sewage past their doors diluted with a smaller proportion of water than that agreed upon when the state legislation authorizing the construction of the sanitary canal was enacted.

LETTERS TO THE EDITOR

Piers for a North River Bridge at New York City Would Effect No Saving in Cost over a Single Span

SIR—The views of Mr. Augustus Smith, published in your issue of Jan. 2, 1913, on the subject of piers in the Hudson River at New York City (also called the North River) for a bridge across that stream are shared by many persons not informed as to the peculiar geological character of that river. The belief that one or more piers in that river would greatly cheapen the construction of a bridge is erroneous, and a word of explanation would seem to be in order.

The bed of the North River consists of a submerged rocky irregular trough or cañon, with an average width of a mile, and along its middle, from 250 to over 300 ft. deep from the water surface to rock. This trough is filled with mud, called euphoniously silt. The water in the middle of the river is 40 to 60 ft. deep. The river bottom is so soft that a diver cannot stand on it. At the depth of 90 ft. from the water surface, which is that of the Pennsylvania R.R.'s tunnels, the silt is still in a half liquid condition. The silt gradually thickens with increasing depth, and becomes a blue clay mixed with gravel overlying the rock. Bridge piers would have to be founded on that rock formation, which is about 100 ft. deeper than the deepest bridge foundations so far built.

To avoid confusion of terms it should be explained that the so called pierhead line is the line along each shore to which the landing piers for ships are built out at right angle to the river, with foundations mostly on long piles. The width of the river between these pierhead lines is from 3000 to 4000 ft., and the Government will not allow any bridge piers in that width.

Assuming now, for illustration, a bridge over this width with two spans each, say, 1500 ft. clear (or 1600 ft. on centers of piers), then the cheapest plan would be that for a cantilever bridge in which the two middle spans would be flanked with anchor spans, one over each shore, four spans in all. Each middle span would consist of a cantilever arm 800 ft. long, supporting one end of an independent truss, also 800 ft. long, the other end of the truss resting on a pier in the middle of the river. This symmetrical arrangement would give the smallest middle pier, as it would get the load from each middle span for a length of only 400 ft., or 800 ft. in all. Assume further this pier to be on top only 150x30 ft., and to rest on a foundation, say, 270 ft. below water. Allow 20 tons per sq.ft. pressure upon the foundation without allowing for the displacement of water, which gives the safer dimensions. More could not safely be allowed for a foundation which could not be ocularly inspected. A size of foundation is thus obtained, which, together with the pier would cost, at a low estimate, six million dollars. Piers may be built for less, but should not be built if absolute safety is to be paramount. A pier with a greater depth would, of course, cost more. Six million dollars will buy 40,000 tons of nickel steel, which, added to the amount of steel and cost of the cantilever structure, is more than enough to build a suspension bridge of the same capacity with a 3000-ft. span. Similarly, with two deep piers, no considerable economy could be discovered in the total cost of structure.

Therefore, one or two piers in this river do not cheapen the cost of a bridge. The economy leans to the side of a suspension bridge with a single span between pierhead lines. It is this fact that caused the writer to acquiesce many years ago in the decision of the War Department that the bridge shall, in the interest of unobstructed navigation, have a single span from pierhead line to pierhead line.

There is need of warning against a common error. That is, estimating the cost of construction too low, and with insufficient allowance for contingencies and delays, interest during construction, cost of administration and right of way, and the connections and approaches without which a bridge is not complete. It produces false notions of what such a large work really costs and as to the amount of money which must be provided. That has happened thus far with every engineering work of unprecedented magnitude.

GUSTAV LINDENTHAL.

68 William St., New York.
Jan. 7, 1913.

Effect of Cocoanut Oil and of Sugar on Concrete

Sir—I would like to know if any of your readers have had any difficulty in getting good results from concrete work in or around sugar refineries. I have had it disintegrate when I have used special care in mixing, placing and covering with damp cloths until set, and again I have obtained good results with the same material and mixture but with conditions which seemed less favorable. Laboratory experiments when I have added various percentages of sugar with cement and with cement and sand give such conflicting results that I am at a loss to know what the causes are which have affected my results.

F. E. P.

Brooklyn, N. Y., Dec. 16, 1912.

Sir—Will you advise me if you know of any material that can be incorporated with concrete that will make it oil-proof and protect it against the destructive action of animal and vegetable oils?

I am building a reinforced-concrete warehouse for the storage of cocoanut oil and by careful tests I have found that the destructive action of the oil in converting the lime of the portland cement into lime soap is very rapid. By subjecting a sample of hardened concrete to the action of oil for two weeks, the deterioation is very noticeable.

If either you or any of your readers can suggest a practicable remedy for protecting the concrete, I shall be

obliged. Several protecting paints to be applied to the surface have been suggested by the various manufacturers, but these are open to the objection that the abrasion of the surface due to rough usage would remove the paint and expose the floor to the destructive action of the oil.

WM. COPELAND FURBER.

Philadelphia, Dec. 16, 1912.

[The destructive effect of vegetable and mineral oils on concrete has been frequently noted, but we do not know of any protective measures that have been successful. The possible destructive effect of sugar is new to us; if any reader can throw any light on the subject, the information would be welcome.—ED.]

Upward Water Pressure on the "Reversed Dam"

Sir—In your issue of Dec. 19, 1912, p. 1142, a "reversed dam" is described by Frank C. Osborn. In considering the pressures exerted on this dam Mr. Osborn ignores a force or set of forces of enormous magnitude and importance. The force referred to is the upward pressure of water underneath the horizontal slab of this dam. If this force should reach anything like its full possible value, the resultant would be upward, and the dam would float away. The stability of this dam depends solely upon its being perfectly glued to a foundation of a solid rock—147 ft. wide in the direction of the stream and without seam in any direction, in the example analyzed in the article—glued or cemented so that no water whatever can ever penetrate beneath the horizontal slab.

In view of the periodic failures of dams by reason of water pressure beneath them lifting them off their foundation, it would be a bold spirit indeed who would attempt a dam of any magnitude along the lines of this one. He should be compared with the great military geniuses in his disregard for human life. Such a one ought to be compelled to reside just a little downstream from his structure.

It is to be fervently hoped that the always self abasing and willing profession of engineering will not be compelled to shoulder the responsibility of a series of disasters that dams of this sort would no doubt inaugurate.

The writer feels intensely serious about this matter, so much so, in fact, that he desires this letter to be considered as a warning, from the minority, perhaps, but a constantly growing minority. It is by no means the universal opinion of the profession that under pressure on dams does not exist or can be ignored. Books and specialists have not yet caught up with this advance, but they will be forced to it in time. It is to be hoped that there have been enough horrors already to supply the necessary material to effect this conversion.

EDWARD GODFREY.

Monongahela Bank Bldg.,
Pittsburgh, Penn., Dec. 24, 1912.

[The above letter was submitted to Mr. Osborn and he has replied as follows:]

Sir—If Mr. Godfrey had read the article a little more carefully he would have noted that the spirit of it was to illustrate a novel idea in dam construction, to indicate a simple, direct and compact method of calculation for obtaining the foundation pressures, and more particularly to call attention to the peculiar results obtained in the comparative calculations for the factor of safety against overturning.

He would have discovered also that the question of upward pressure on the base was not ignored, but, on the contrary, that complete calculations are given for foundation pressures and for overturning under the heading "Backwater Pressure."

It may be a possible theoretical assumption that the full hydrostatic head would act over every foot of the foundation from heel to toe, but this implies an entirely unobstructed entrance for water, no point of contact between the dam and its foundation, no drainage system and the positive prevention of any escape of water at the toe. If it is possible to provide such a preventative at the toe then it must also be possible to provide such a one at the heel and thus avoid any upward pressure whatever.

This question has, however, been most thoroughly and ably discussed before the American Society of Civil Engineers during the past year and was not considered pertinent to the article in question.

Mr. Godfrey is in error when he says it is necessary that no water whatever be permitted under the base of the reversed dam. This is proved by the calculations above referred to, which show stability under a very considerable head acting uniformly over the entire base. Further calculations will show, for a full static head at the heel and zero pressure at the toe, a substantial downward resultant, a moderate pressure at the toe and a tension at the heel so slight as to be easily provided for. It is apparent that if additional weight is desired the thickness of the base can be readily increased, or loose material superposed.

FRANK C. OSBORN.

Cleveland, Ohio, Jan. 6, 1913.

Effect of Moisture on the Strength of Concrete: An Explanation of Concrete Drain Tile Failures

Sir—A study of the existing literature on mortars and concretes seems to indicate that the factors affecting their strength are fairly well understood. Many reports are available of exhaustive investigations as to the variations in the strength of concrete resulting from varying proportions of aggregate, age and quality of cement, varying sizes and quality of aggregate, different methods of mixing and curing, different methods of testing, and of various impurities in the mixing water or aggregate.

To make the assertion that after it has set the amount of moisture present in a portland-cement concrete has an effect upon its strength of sufficient amount to be of practical importance in some uses of concrete, and that this fact is not recognized in concrete literature may astonish, yet investigations recently made seem to indicate that such is the case. When we consider, however, that only within the past two years has it become an established fact that concrete expands and contracts with changes in the amount of moisture present just as wood does, it does not seem altogether impossible that we have been overlooking such a simple thing as the fact that the

presence of water materially affects the strength of concrete.

Several failures of concrete drain tile in the state of Iowa have caused concern, and various ways of testing tile have been proposed. But not infrequently large numbers of concrete drain tile fail after being laid and covered, notwithstanding the fact that every joint is tested before laying and withstands a larger load than they are subjected to in the ditch. The significant fact about the failures is that they all seem to occur within a few hours after laying, but not immediately after covering. All joints that withstand the earth pressure for, say, twelve hours, prove to be permanently safe, even though the depth of covering is afterward increased. It was thought that the explanation of this action might be that the tile are tested in a fairly dry condition and that the moisture which soon saturates the walls after the tile are laid in some way has a weakening effect. It was at first thought that the weakening must be due to some sort of chemical action.

To learn whether or not this is the explanation, experiments were begun in the testing laboratory of the College of Applied Science, State University of Iowa, about a year ago. It was soon proved that a 1:3 portland-cement mortar cured in air under conditions similar to those commonly obtained in the manufacture of cement drain tile, was weakened from 40 to 50% by being soaked in water. It was farther proved that this weakening resulted at once, that is, the full weakening effect came about just as soon as the specimens were saturated with water. This fact seemed to indicate that the cause was physical and not chemical.

Many questions immediately arose. How does this weakening vary with different mixtures, with different cements, with different methods of curing? Is the percentage of weakening proportional to the moisture content? Can the mortar be repeatedly weakened and strengthened by repeated wetting and drying? A series of experiments is under way for the purpose of answering some or all of these questions and the results will be published when obtained. The mere fact, however, that a dry mortar may be weakened 50% by the introduction of pure water seems of sufficient importance to warrant its publication at this time. While it is true that a greater part of the concrete made is used in large masses with a sufficient factor of safety to cover such variations, yet the fact remains that if the factor of safety is based upon a strength obtained experimentally upon a dry concrete, it may be reduced 50% by a wetting of the structure. Furthermore, in cases where concrete is used in thin walls subject to bending without reinforcement, such as in drain tile, this weakening may actually cause failure as in the instances cited.

It has long been recognized that the strength of wood varies with the moisture content and tables of ultimate strengths of wood are always based upon a known percentage of moisture present. In view of the above facts, is it not equally important that reports of tests of strength of concretes and mortars contain a statement of the condition of the specimens with respect to moisture content?

SHERMAN M. WOODWARD,
FREDERICK C. YOUNG.

Iowa City, Iowa,
Jan. 2, 1913.

Feathering Paddle Wheels for Self-Propelling Dredges

Sir—On p. 286 of your issue of Aug. 15, 1912 appears a description of the feathering paddle wheel to be used on the dredges "H. F. Taber" and "Robert McGregor," now building for the Arkansas River, and designed in the office of the Chief of Engineers, U. S. Army, at Washington.

You were pleased to quote a portion of what the writer stated in an article on "The Most Economical Type of Boat for Operation on Western Rivers," which appeared in your issue of May 5, 1910, p. 512. The quotation was confined, however, to the latter part of the paragraph in which it occurred, and omitted the items favoring the use of such wheels on our river boats.

I have many times expressed a hope for the trial of such wheels on our river boats, where the service gave any promise of possible satisfactory operating results. Such boats as the Arkansas dredges provide excellent conditions for an experimental installation of such wheels, but unfortunately use the propelling machinery to such a limited extent that they do not determine what result might be found under commercial operation.

It is to be regretted, moreover, that more wisdom was not shown in the Washington office, so that the really most desirable concomitant of the feathering wheel use might have been preserved. I refer to the increased piston speed of propelling engine that can be obtained by the use of such a wheel. This is entirely lost by the designer of these dredges. Similar boats built by the army engineers, but with the usual radial wheel, operate under probably 300 ft. per min. piston speed. The average piston speed of the Western River boat is less than 300 ft. per min. It is this slow piston speed which is most detrimental to fuel economy, and its possible increase, by the use of a feathering wheel, that which makes the installation of such a wheel on one of our river boats advisable. Yet this great advantage is entirely thrown away by the Arkansas-dredge designers when they adopt a stroke of 4 ft. for the propelling engines. The "Detroit III" is securing practically 500 ft. of piston speed, and there is no reason why these Arkansas dredge boats should not have had a similar advantage.

The Washington office also shows great lack of complete information in the design of the cylinder frames for these two dredges. The use of such steel frames on our river boats has developed a decided tendency to crystallize at certain points, and this might be emphasized in the construction shown. The elevation of the inboard end of the frames to some 4 ft. above the deck line should have been avoided; the placing of these frames in parallel, the small angle of some 30° shown as the limit of rudder movement, all point to an uncertain knowledge of proper practice.

Perhaps one of the most peculiar things which has otherwise come to my attention in connection with the design of these dredges, is that of the chimney weighing some three times that which would be accepted practice or thought necessary, accompanied with emphatic assurances of a purpose to preserve lightness.

JNO. M. SWEENEY.
Mechanical Engineer.

1636 Monadnock Block, Chicago,
Dec. 9, 1912.

Limiting the Use of the Chicago Drainage Canal*

SYNOPSIS—The sewage of a part of Chicago and of some outlying territory has been diverted from Lake Michigan and is disposed of by the dilution method by turning it southward through a large canal which, with diluting water from Lake Michigan, discharges into the Des Plaines River, thence by way of the Illinois River into the Mississippi. Federal authority to divert water from the lake was not secured until the canal was about ready for use, 14 years ago, and was then obtained from the Secretary of War, subject to amendment at his discretion and to possible Congressional action. The present Secretary of War now denies an application to increase the amount diverted, on the grounds that since he is convinced that further diversion would interfere with navigation by lowering the level of the Great Lakes, he would not be warranted in sanctioning the increase without authorization from Congress, however much the water may be needed; that the facts presented show no imperative need; and that an existing treaty between the United States and Canada is a further reason why no administrative officer should grant such an application against Canadian protest.

❖

The Sanitary District of Chicago applies to the War Department for permission to increase the amount of water it is authorized to withdraw from Lake Michigan from 4167 cu.ft. per sec., the amount now authorized, to 10,000 cu.ft. per sec.

The Chicago Drainage Canal was opened in January, 1900. It reverses the flow of the Chicago River, which formerly emptied into Lake Michigan, and as a result a portion of the waters of that lake, instead of following their former course through Lakes Huron, Erie and Ontario into the St. Lawrence, are now carried across the watershed into the Illinois River, and through that to the Mississippi and the Gulf of Mexico. The canal thus serves as a system of drainage for the city of Chicago, carrying the sewage of that city southward to the Mississippi, and thus protects the water supply of that city, which is taken from Lake Michigan.

Permission to divert water from Lake Michigan was first granted by my predecessor, Secretary Alger, on May 8, 1899. He permitted a flowage of 5000 cu.ft. per sec., but his permit contained the following conditions:

1. That it be distinctly understood that it is the intention of the Secretary of War to submit the questions connected with the work of the Sanitary District of Chicago to Congress for consideration and final action, and that this permit shall be subject to such action as may be taken by Congress.
2. That if, at any time, it becomes apparent that the current created by such drainage works in the south and main branches of Chicago River be unreasonably obstructive to navigation or injurious to property, the Secretary of War reserves the right to close said discharge through said channel or to modify it to such extent as may be demanded by navigation and property interests along said Chicago River and its south branch.

Subsequently, during the administration of Secretary Root, the amount of the current permitted to be taken was modified or restricted until Dec. 5, 1901, when it was fixed at the amount now permitted, and these permits contained the condition: "that the permission herein given shall be subject to such modifications as in the opinion of the Secretary of War the public interests may from time to time require."

On Mar. 14, 1907, an application made for permission to divert an additional 4000 cu.ft. per sec. for the purpose of reversing the current of the Calumet River and flowing that river also through the canal to drain the southern portion of Chicago was denied by Secretary Taft in an opinion in which he referred once more to the desirability of submitting "this question of capital and national importance to the Congress of the United States."

It is clear that even under the conditions heretofore manifested on these applications, the proposition to divert the water of Lake Michigan into another watershed has not been entertained without hesitation and careful restriction by my predecessors The propriety of obtaining congressional sanction for the project has been pointed out from the beginning; and the form in which the permit has been granted even for the moderate amount of diversion permitted, has been so phrased as to indicate that the permission was predicated upon the absence of any substantial injury to commerce.

The sanitary canal has never received the direct sanction of Congress. It was built solely under the authority of the State of Illinois, as given in its 1889 general act for creating sanitary districts. And although pursuant to the suggestion of my predecessors the question of the propriety of its diversion of water from Lake Michigan was presented urgently in the reports of the Chief of Engineers for the years 1899 and 1900 as transmitted to Congress, no action upon the question has ever been taken by that body.

In the argument before me it was urged that the present canal represented the growth and development of a national policy expressed in two acts of Congress, 1822 and 1827, which authorized the construction of a canal "to connect the Illinois River with Lake Michigan," thus connecting the two watersheds. (Acts of Mar. 30, 1822, and Mar. 2, 1827). But these statutes authorized a canal for the purpose of navigation and not sanitation. (Missouri vs. Illinois, 200 U. S., 526). The Illinois and Michigan Canal, actually constructed under their authority, derived its water for navigation purposes from the Calumet, Des Plaines and Chicago Rivers, and not from the Lakes. And although in the latter part of its existence it was used to a very slight extent to help purify the waters of the Chicago River and thus sanitate the city of Chicago, such a purpose could not have been dreamed of at the time its construction was authorized by Congress, 90 years ago. I cannot see that its authorization and construction offer the slightest congressional sanction for the great canal now under discussion, which was not even contemplated until much more than half a century later.

Even at the time when the present canal was constructed and opened it is very evident that its ultimate possible effect upon the navigation of the Great Lakes was not clearly realized by those interested in that navigation. The evidence before me indicates that the withdrawal of water from Lake Michigan, at Chicago, would require about five years to produce its full effect upon the level of the Great Lakes (see report of International Waterways Commission on Chicago Drainage Canal, p. 7), and that this effect would be still further obscured by periodic oscillations in the lake levels. These facts may easily explain any inaction on the part of the Nation and their representatives to this withdrawal of water and make it clear that any argument of implied acquiescence must be scrutinized with unusual care.

In this respect the situation is now very different. The present application was opposed by representatives of 23 cities and 6 states interested in harbors and commerce upon the Great Lakes, notably the cities of Duluth, Milwaukee, Toledo, Cleveland and Buffalo. It was opposed by representatives of the navigation interests engaged on the Chicago River as well as on the Great Lakes, and by the official representatives of the Canadian government as well as private Canadian interests engaged in the navigation of the Lakes and the St. Lawrence River, including representatives of the cities of Kingston and Montreal.

A very careful consideration of the voluminous evidence and statements submitted, as well as a consideration of the reports of other commissions and boards of engineers who have investigated the subject, leaves no doubt in my mind that the withdrawal of 10,000 cu.ft. per sec. would substantially interfere with the navigable capacity of the Great Lakes and their connecting rivers. The Chief of Engineers, whose statutory authority in passing upon this application is concurrent with and independent of my own, and whose opinion upon such a question of scientific conclusion must be given especial weight, so states in his recommendation. His conclusions are corroborated by the authority of other boards of investigation, notably the report of the International Waterways Commission of Jan. 4, 1907.

Careful observations and calculations conducted under the offices of the United States Lake Survey and reported through the Chief of Engineers, covering observations for the last 46 years, indicate that a withdrawal of 10,000 cu ft. per sec. would reduce levels at various places as follows

	In.
Lakes Huron and Michigan	6.9
Lake St. Clair	6.3
Lake Erie	5.4
Lake Ontario	4.5
St. Lawrence River, at Rapide Plat	4.8+

The foregoing effects would be produced at mean lake levels; the lowering effects would be much greater at low-

*Decision in full of Henry L. Stimson, Secretary of War, dated Jan. 8, 1913.

water periods—the precise time when any additional shortage would be most keenly felt. This reduction would create substantial injury in all of the American harbors of the Great Lakes and in the St. Marys, St. Clair and Detroit Rivers. It would produce equal injury in Canadian harbors on the Great Lakes, and a still greater injury on the lower St. Lawrence, the Canadian officials claiming a probable lowering effect of 12 in. at Montreal at low water.

The United States has improved about 106 harbors and rivers on the Great Lakes affected by this diversion and has spent on such improvements over $90,000,000. The Canadian government has improved over 50 harbors on Georgian Bay and Lakes Huron, St. Clair and Ontario. By treaty, American vessels are accorded equal rights of navigation with Canadian vessels in all these waters, including the St. Lawrence River. The reduction of the water in these harbors and channels would diminish to just that extent the amount of these improvements, and would nullify to just that extent the effects of the moneys which have been appropriated for that purpose by the respective governments. Connecting various portions of these waterways are the two canals at the Sault Ste. Marie, the Welland Canal, and a number of canals on the St. Lawrence River. The available depth of water over one or all sills of each of these canals would be affected, and in some cases reconstruction might even be made necessary.

The enormous lake traffic which uses these harbors and these rivers is increasing with great rapidity, both in gross volume and in the size and average draft of the vessels employed therein. The Chief of Engineers reports that to lower the water surface 6 in. would reduce the permissible load of one of the large modern vessels by from 300 to 550 tons, with a consequent loss of from $3600 to $7500 in freights for such vessel per season. The International Waterways Commission reported that it would be a conservative estimate which would make the loss to the navigation interests resulting from a reduction of 6 in. in the depth of water as $1,500,000 per annum, or a sum which, capitalized at 4% would amount to a loss of $37,500,000 (see third progress report of International Waterways Commission of Dec. 1, 1907, p. 24). The lowest careful estimate of injury to American vessels alone is reported by the Chief of Engineers as $1,000,000 per year.

The argument was made before me that, owing to the well known fact that the levels of the lake vary, owing to winds and change of barometric pressure, by amounts even greater than the reduction, which would be caused by this canal, therefore, the proposed reduction is of no consequence. This argument is well disposed of in the report of the International Waterways Commission of Jan. 4, 1907, on page 8, as follows:

> It is evident that the average level of the lake may be lowered considerably without the change becoming immediately apparent, and that fact has been used as an argument to prove that the lowering caused by the Chicago Drainage Canal is of no consequence to those interested in navigation. Since they cannot see it they will not know it and will not feel it. The argument is fallacious. It is true that they cannot see it immediately, but they will soon feel it and will know it through the most costly means of acquiring knowledge—the injury to their material interests. The oscillations will remain the same as before, but low water will fall lower and high water will rise less high. The average draft of vessels must be diminished by the amount that the average level is lowered unless the depth be restored by remedial works.

In a word, every drop of water taken out of Chicago necessarily tends to nullify costly improvements made under direct authority of Congress throughout the Great Lakes, and a withdrawal of the amount now applied for would nullify such expenditures to the amount of many millions of dollars, as well as inflict an even greater loss upon the navigation interests using such waters.

On the other hand, the demand for the diversion of this water at Chicago is based solely upon the needs of that city for sanitation. There is evolved in this case no issue of conflicting claims of navigation. The Chief of Engineers reports that so far as the interests of navigation alone are concerned, even if we should eventually construct a deep waterway from the Great Lakes to the Mississippi over the route of the sanitary canal, the maximum amount of water to be diverted from Lake Michigan need actually be not over 1000 ft. per sec., or less than a quarter of the amount already being used for sanitary purposes in the canal. This estimate is confirmed by the report of the special board of engineers on the deep waterway from Lockport, Ill., to the mouth of the Illinois River, dated Jan. 23, 1911. It is also confirmed by the practical experience of the great Manchester Ship Canal in England. From the standpoint of navigation alone in such a waterway too great a diversion of water would be a distinct injury rather than a benefit. It would increase the velocity of the current and increase the danger of overflow and damage to adjacent lands.

We have, therefore, presented in this case claims of entirely different characters and jurisdictions—the claim of sanitation on the one side and of navigation on the other; the vital interest of a single community on the one side and the broad interest of the commerce of the nation on the other.

The discretion given to the Secretary of War under Sec. 9 and 10 of the act of 1899 is very broad, but I have very grave doubts as to whether it was intended to authorize him to grant a permit which would inflict a substantial injury upon commerce in order to benefit sanitation. The entire purpose and scope of that legislation was to make him the guardian of the commercial interests of the nation represented in their waterways. And while he sometimes under that statute must decide that the interests of one class of transportation are less important and must yield to the conflicting interests of another class, I have considerable doubt whether it was intended to give him authority to sacrifice substantial interests of navigation to entirely different claims over which he normally has no jurisdiction whatever.

But however that may be, and without resting my decision upon the question of my legal authority, I am quite clear as a matter of discretion that under the facts presented by this case no further diversion of water should be permitted at Chicago without the direct sanction of the Congress of the United States. I do not for one moment minimize the importance of preserving the health of the great city of Chicago; but when a method of doing this is proposed, which will materially injure a most important class of the commerce of the nation and which will also seriously affect the interests of a foreign power, it should not be done without the deliberate consideration and authority of the representatives of the entire nation. The growth of Chicago is phenomenal and its representatives are quite unwilling to put any final limit to the demand which may be made upon the waters of Lake Michigan for its sanitation under the system now in use. I have before me the report in 1911 of the president of the sanitary district, in which he says:

> I am of the opinion that the presumption that our water-supply is to be limited to 10,000 cu.ft. per sec., or 600,000 cut.ft. per min., is gratuitous and mischievous and should not be voiced by the officials of this district I believe that we should have the volume requisite to our needs as they appear and are justified.

It is therefore quite conceivable that compliance with their sanitary needs according to this method of sanitation may eventually materially change this great natural watercourse now existing through the Lakes. The weighing of the sanitation and possibly the health of one locality over against the commerce of the rest of the nation and the consideration of our relations and obligations to Canada in respect to a great international waterway are not matters of mere technical or scientific deduction. They are broad questions of national policy. They are quite different in character, for example, from the question of fixing the proper location of a pierhead line or the height or width of a drawbridge over a navigable stream—fair samples of the class of questions which come to the Secretary of War for decision under the above-mentioned act of 1899. While the researches and opinions of experts in the respective fields are necessary and useful as an assistance toward reaching a fair and proper policy, the final determination of that policy should belong not to an administrative officer but rather to those bodies to whom we are accustomed to entrust the making of our laws and treaties.

In my view of the proper exercise of my discretion in this matter the foregoing considerations are sufficient for a decision of this case. Having reached the conclusion that the proposed diversion of the waters of Lake Michigan would substantially injure the interests of navigation on the Great Lakes, which it is my legal duty to protect, it would clearly follow that the present application should be denied.

I have carefully examined, however, the evidence which both sides have introduced bearing upon the sanitary needs of the city of Chicago, and my conclusion is in no way shaken. I am not persuaded that the amount of water applied for is necessary to a proper sanitation of the city of Chicago. The evidence indicates that at bottom the issue comes down to the question of cost. Other adequate systems of sewage disposal are possible and are in use throughout the world.

The problem that confronts Chicago is not different in kind, but simply larger and more pressing than that which confronts all of the other cities on the Great Lakes, in which nearly 3,000,000 people of this country are living. The urban population of those cities, like that of Chicago, is rapidly increasing, and a method of disposition of their sewage which will not injure the potable character of the water of the Lakes must sooner or later be found for them all. The

evidence before me satisfies me that it would be possible in one of several ways to at least so purify the sewage of Chicago as to require very much less water for its dilution than is now required by it in its unpurified condition.

A recent report of the engineer of the sanitary commission [meaning Drainage Canal?—Ed.] (Oct. 12, 1911) proposes eventually to use some such method, but proposes to postpone its installation for a number of years to come, relying upon the present more wasteful method in the meanwhile. It is manifest that so long as the city is permitted to increase the amount of water which it may take from the Lakes, there will be a very strong temptation placed upon it to postpone a more scientific and possibly more expensive method of disposing of its sewage.

This is particularly true in view of the fact that by so doing it may still further diminish its expenses by utilizing the water diverted from the Lakes for water power at Lockport, Ill. But it must be remembered that for every unit of horsepower realized by this water at Lockport four units of similar horsepower would be produced at Niagara, where the natural conditions are so much more favorable. Without, therefore, going more into detail in a discussion of this question, I feel clear that no such case of necessity has been presented by the evidence before me as would justify the proposed injury to the many varied interests in the great waterways of our lakes and their appurtenant rivers.

It remains only to consider certain special arguments that have been pressed upon me. It has been urged that the levels of the lakes, even if lowered, could be restored by compensating works. To a certain extent that is true. But the very nature of this consideration offers another illustration of the importance of having the whole question passed upon by Congress. Such compensating works can only be constructed by the authority of Congress and at very considerable cost. It is not a matter which is in the hands of the Secretary of War. Permission to divert water which will at one and the same time nullify the effect of past appropriations and make necessary similar expenditures in the future, should be granted only with the express consent of the body in whose hands the making of such appropriations and the authorization of such works rest.

Furthermore, in most cases such compensating works could only be constructed with the joint consent of our neighbor Canada. The United States Government alone would be unable, even if it were willing to spend its own funds, to compensate for the damage done through the lowering of these levels unless Canada were willing to join in constructing the portion of such works which would necessarily stand upon Canadian soil.

The question, therefore, becomes not merely national, but international, and this leads me to the consideration of the arguments which were urged by both sides in reference to the treaty with Great Britain in respect to Canada of Jan. 11, 1909. A careful consideration of that treaty fails to indicate to me that it is in any way controlling upon the questions now before me. It gives to the citizens of both countries certain mutual rights of navigation in the waters of the Great Lakes and their connecting rivers; but beyond that the question of the right to this diversion at Chicago seems to me to have been carefully excluded. The applicants for the permit have urged upon me that Art. 8 of the treaty gives a preference to the uses of water of the lakes for domestic and sanitary purposes over the uses of such water for navigation. Art. 8, however, applies only to future cases brought before the International Joint Commission; and furthermore I am clearly of the opinion that the domestic and sanitary purposes referred to in that article were intended to be the "ordinary" uses of such waters for domestic and sanitary purposes referred to in Art. 3. It would be quite contrary to our own national policy to give such a preference to an extraordinary sanitary use of such a character as to create a substantial injury to navigation.

The matter has been before our own Supreme Court in the case of the United States vs. the Rio Grande Dam & Irrigation Co. (174 U. S., 690). In that case the Supreme Court held that a company which proposed to take the water of the Rio Grande River for the purpose, among others, "of supplying water to cities and towns for domestic and municipal purposes" could be prevented from so doing when the result would be a substantial injury to the navigability of the Rio Grande River farther down. In its opinion the court said:

> The question always is one of fact, whether such appropriation substantially interferes with the navigable capacity within the limits where navigation is a recognized fact. In the course of the argument this suggestion was made, and it seems to us not unworthy of note, as illustrating this thought. The Hudson River runs within the limits of the State of New York. It is a navigable stream and a part of the navigable waters of the United States, so far at least as from Albany southward. One of the streams which flows into it and contributes to the volume of its waters is the Croton River, a non-navigable stream. Its waters are taken by the State of New York for domestic uses in the city of New York. Unquestionably the State of New York has a right to appropriate its water, and the United States may not question such appropriation, unless thereby the navigability of the Hudson be disturbed. On the other hand, if the State of New York should, even at a place above the limits of navigability, by appropriation for any domestic purposes, diminish the volume of waters, which, flowing into the Hudson, make it a navigable stream, to such an extent as to destroy its navigability, undoubtedly the jurisdiction of the National Government would arise and its power to restrain such appropriation be unquestioned; and within the purview of this section (act of Sept. 19, 1890, ch. 907) it would become the right of the Attorney General to institute proceedings to restrain such appropriation.

The treaty, however, contains provisions in its Art. 10 by which "any questions or matters of difference arising between the high contracting parties involving the rights, obligations, or interests of the United States or of the Dominion of Canada, either in relation to each other or to their respective inhabitants, may be referred for decision" to an international joint commission established by the said treaty. The hearing before me brought forth the fact that the Government of Canada regards the proposal contained in this application as one which affects the material interests of that country. The establishment by formal treaty between the two countries of a tribunal with jurisdiction to decide just such questions seems to me to afford an additional reason against the assumption of jurisdiction to decide the question by an administrative officer of one of those countries.

In short, after a careful consideration of all the facts presented, I have reached the following conclusions:

(1) That the diversion of 10,000 cu.ft. per sec. from Lake Michigan, as applied for in this petition, would substantially interfere with the navigable capacity of the navigable waters in the Great Lakes and their connecting rivers.

(2) That that being so, it would not be appropriate for me, without express congressional sanction, to permit such a diversion, however clearly demanded by the local interests of the sanitation of Chicago.

(3) That on the facts here presented no such case of local permanent necessity is made evident.

(4) That the provisions of the Canadian treaty for a settlement by joint commission of "questions or matters of difference" between the United States and Canada offer a further reason why no administrative officer should authorize a further diversion of water, manifestly so injurious to Canada, against Canadian protest.

The prayer of the petition is therefore denied.

The Use of Steam Turbine Driven Centrifugal Pump Units to carry the peak of the load in water-works pumping stations is exemplified in the new water-works of Youngstown, Ohio. We are informed that contracts were let on Dec. 14 for two 7,500,000-gal. pumping units for the new pumping station at Youngstown. One contract was for a triple-expansion reciprocating pump, let to the William Tod Co., of Youngstown, at a price of $72,110, for a pump with a guaranteed duty of 163,000,000 ft.-lb. A contract was also let to the Kerr Turbine, with a guaranteed duty for the unit of 80,000,000 ft.-lb. The contract price for this unit was $9989.

The Gatun Dam Sluice Gates—The first of the sluice gates for the spillway at Gatun Dam was placed in position on Dec. 12, and two others were placed on the following day.

These gates weigh 44 tons each, with seals and bearings attached. They are built up of structural steel and are 47 ft. 10¼ in. in length and 19 ft. high. They fit into steel-lined grooves in concrete piers, and only ⅛ in. play is allowed in each groove. On account of this small margin, the size of the gates, and the nicety required in their construction, it was thought that there might be difficulty in dropping them into place without removing the end rollers, rocker bearings, and the sealing devices. But no difficulty was experienced, although it developed that the play in one of the grooves was only $\frac{1}{16}$ in.

Fourteen gates are required for Gatun Spillway, and they have already been erected at a point a little north of the Division Office, a distance by rail of about one mile and a half from the spillway. They are carried from the erecting grounds to the spillway on a single flat car, upon which they are loaded upright by two locomotive cranes. In the construction of the piers between which the gates operate, a high trestle was built, and upon this the cars containing the gates were pushed out over the weirs which they close. The cranes then lifted them from the cars, and lowered them slowly while men steered them into the grooves. The first gate was placed in about an hour, and the second and third in a few minutes each.—"Canal Record," Dec. 18.

NOTES FROM THE ENGINEERING SCHOOLS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—A fund of 15,000, to be known as the "Ellen H. Richards Fund for Sanitary Research," has been raised by friends of Mrs. Richards. It is hoped to increase the fund from time to time; the income is to be used for fellowships to advanced students who shall be competent to pursue sanitary research, for the employment of research assistants, or in such other ways as may best promote the cause of the chemistry of sanitation. Mrs. Richards was a graduate of this institution, and instructor in sanitary chemistry from 1884 up to her death in 1911.

COLORADO AGRICULTURAL COLLEGE—A new hydraulic laboratory is being constructed jointly by the experiment station of this institution and the U. S. Office of Experiment Stations, Department of Agriculture. It is believed by the designers that the present methods of estimating the flow along streams or ditches are based on data which are not wholly applicable to present-day conditions in irrigation work, and the function of this laboratory will particularly be to show the proper corrections of older data.

This laboratory, it is reported, will cost $10,000. There is to be, first, a large main reservoir of concrete, with a capacity of ½ acre-ft. of water. The release from this reservoir is through a large headgate on one side and the flow is through a flume to the testing tanks. There are several of the latter in order to facilitate the experiments. The contents of these tanks have been measured carefully so that the exact capacity of each may be accurately known. The results of experiments may be published by either state or federal authorities.

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The Tank Steamer "Rosecrans" Went on the Rocks of Peacock Spit at the mouth of the Columbia River, near Astoria, Ore., on Jan. 7, and was lost with 33 of her crew.

The Bursting of a Compressed-air Pipe at the Brooklyn end of the Manhattan Bridge, New York City, on Jan. 7, precipitated two workmen from a scaffold to the street, 40 ft. below, causing them serious injury. The injured were members of a gang of painters, who were working on the pipe line at the time of the accident.

The Collapse of Two Buildings, at Rome, Italy, on Jan. 8, caused the death of 10 people and the injury of as many more. It is stated in press dispatches that the foundations of the National Industrial Museum were weakened by excavation work nearby, and when this structure collapsed it carried down with it an adjoining apartment house.

An Explosion in the New York Subway Extension, at 103d St. and Lexington Ave., New York City, on Jan. 9, killed one and injured four of the tunnel workers. A blast missed fire when it was attempted to set it off with the battery and then exploded shortly afterward when the men went near to find why the charge did not go off.

The Steamer "Uranium" Ran Aground at the entrance to Halifax harbor, Nova Scotia, on Jan. 12, during a thick fog, and three hours later transferred her passengers, to the number of 839, to rescue steamers sent to her aid. The vessel struck on a sloping shore with her bow on the rocks and her stern in deep water. She was making her first trip as the pioneer ship of a new transatlantic line.

A High Flood, in the Ohio River, did damage amounting to a million dollars last week, at Pittsburgh, the water there reaching a stage of 31.3 ft., the fourth highest on record. The U. S. Weather Bureau, on Jan. 12, reported conditions as follows:

The crest of the principal flood in the Ohio River is between Cincinnati and Louisville. As a result of continued rains for 48 hours, the second rainy period within a week, the river is again in flood in its upper reaches, but the second flood wave will not be so severe as the first one was.

A stage of 62 or 63 ft. is indicated for Cincinnati on Tuesday, and on the same day it is expected that the flood stage at Paducah, Ky., 43 ft. will be reached. The flood stage at Cairo, Ill., 45 ft., is indicated for Wednesday.

Panama Canal Excavation during December totaled 2,815,816 cu.yd., a daily average of 122,632 cu.yd. for each of the 25 working days. Rainfall for the month was 6.51 in. The amount of concrete laid in December was 62,907 cu.yd. and 196,426 cu.yd. of fill were placed in dams.

St. Paul's Cathedral, in London, is in danger of undermining from a projected new subway and station, according to a report by Sir Francis Fox, the eminent British engineer, made to the Dean and Chapter of St. Paul's, on Dec. 30, 1912. After describing his examination of the edifice, Sir Francis says: "The Cathedral is overloaded; it is actually moving and cracking, and now a proposal is brought forward, which can in no way contribute to its safety, but may at no distant date, bring about serious injury. I am of the opinion that this covered way and station should on no account be permitted in such close proximity to the Cathedral."

The London County Council must now decide if the work will be continued in the face of such advice.

The Guyandot River Bridge Wreck, near Huntington, W. Va., on Jan. 1, 1913, is covered by an account in the "Railway Age Gazette," of Jan. 10, credited to an officer of the Chesapeake & Ohio Ry. According to this, three 150-ft. iron single-track spans were being replaced by double-track steel spans, and work was in progress on the middle one. The floor of this span was supported on pile falsework, the old trusses having been taken down and the new trusses not yet erected. The river was 8 ft. above low-water, and the current swifter than at any time since the piles had been driven. Rock is about 20 ft. below low water, and the piles went to rock through overlying sand. There had been no settlement prior to the accident. The train before the wrecked one, an hour earlier, passed over without indications that anything was wrong, although the bridge gang watched for signs of settlement. The next train, a westbound freight, moving slowly across the bridge, was wrecked by settlement of the upstream side of the falsework; the engine and one car turned over and fell into the river, carrying down the falsework. The engineman of the train and six bridgemen were killed. The division supervisor of bridges and buildings had examined the bridge before the wrecked freight crossed, and pronounced it safe. Undermining of the piles is supposed to have caused the accident. Timber is floated down the Guyandot, and some logs may have lodged against the bottoms of the piles and caused scour.

Three Transatlantic Liners Went Aground in New York Harbor during the week just past, owing to the difficulty of navigating in the prevalent heavy fogs. On Jan. 4 the Hamburg-American liner "Amerika" out-bound, ran aground on the eastern edge of the channel off Bay Ridge, in Brooklyn. On Jan. 7, the White Star steamer "Adriatic," also outbound, attempted to anchor near Bedlow's Island to wait for the fog to disperse, but could not find anchorage and drifted aground just south of Governor's Island, off Van Brunt St., Brooklyn. On Jan. 9 the Red Star steamship "Kroonland" went aground on the edge of the Ambrose Channel somewhat farther out of the harbor than the other two. All of the ships were able to get away at high tide and proceeded on their voyages.

Electric Traction on 450 miles of main-line track of the Chicago, Milwaukee & Puget Sound R.R. or between Harlowtown, Mont., and Avery, Idaho, is contemplated according to reports (unofficial) from the U. S. Department of the Interior. It appears that a 50-year grant has been made to the Great Falls Power Co., of Montana, to transmit power over the public domain. The company already has its transmission line built, under a termless revocable permit, serving mines at Butte and Anaconda, and all classes of power consumers, but the railroad company is reported unwilling to have proceeded with its work under the older permit. The rental charge for the right-of-way during the first ten years will be five mills per 1000 kw.-hr.

This power company also supplies the Butte, Anaconda & Pacific Ry., which operates about 30 miles of single-track line with a 2400-volt direct-current line. (See Eng. News, Aug. 15, 1912). As 16 miles of this road is jointly operated with the C. M. & P. S. R.R., it is possible that the entire system of the latter may be similar—though that fact has not been announced.

A Derailment on the Chicago Elevated Loop, in the business district of Chicago, which forms the terminal for all the elevated railway lines, occurred on Jan. 8, and resulted

in a car falling from the structure. A three-car train of the Chicago & Oak Park Elevated R.R., had just turned the right-angle curve from Van Buren St. to Fifth Ave. (going north on Fifth Ave.) when the rear car left the rails and after bumping over the ties for a short distance it fell from the structure into the street.

The accident occurred in the early morning when traffic was light. Only two passengers were in the rear car and when this was derailed they had time to run forward to the next car before the other fell. The forward truck of the derailed car remained upon the structure. It has been suggested that as this was a light trail car (without motors) it might have been subjected to exceptional shock and vibration in rounding the curve at high speed. This is the more likely for the reason that the curve is intersected by another curve in the opposite direction, this being a junction of two lines at right angles, so that the angle of the crossing frogs is very flat. The guard timbers are extended as nearly to the intersection as possible, and the damage to them begins just beyond the frog, indicating that the truck was derailed at the crossing-frog and jumped the guard-timber while still on the curve, the wheels being in such position that the guard could not guide them into position. On the tangent the guard timbers were torn and splintered, and the ends of some of the ties broken off by the car in falling over.

There has been some complaint in the past at the speed at which trains frequently pass these sharp curves on the four corners of the loop. These curves are of 90- and 95-ft. radius. At two of the corners there are junctions with grade crossings on the curves, and as no superelevation can be introduced the motion is felt very distinctly by the passengers in the trains. These grade crossings, also, with their flat-angled crossing frogs, make very rough-riding track and cause considerable noise and jar in the trains. The speed is supposed to be limited to 8 m. p. h., but it is suggested that this should be reduced to 6 m. p. h. As every train passes all these corners (there being no through routes) the wear on the track is very severe, and the opportunities for maintenance and renewal work are limited. The city has ordered an investigation as to the cause of the accident, including the condition of both the track and the rolling stock.

Possible Danger to the Water-Supply of New York City is given as a reason for the denial of an application to locate a tuberculosis hospital for Westchester County in the Croton drainage area. The application was denied by the State Department of Health after two hearings, at which a number of sanitary engineers and others appeared both for and against the location. The hospital was to have been placed on a farm of 277 acres, through which flowed two brooks, which empty into the Croton Reservoir. Commenting on the denial of the application, it is stated in the monthly bulletin of the New York State Department of Health for Nov. 12, that:

While undoubtedly it would be possible to dispose of the sewage from an institution of this kind so that it would not be a menace to the water-supply, this involves expert and efficient management. Having in mind the effect of political control over the management of such institutions, the Commissioner held that there can be no positive assurance that the sewage-disposal plant would always be operated so that no contamination of the New York water-supply would result, and therefore he was unable to assume the responsibility of approving the site in question. Other sites are available where these dangers do not exist, and the Commissioner felt obliged to deny the application of the Board of Supervisors.

PERSONALS

Mr. Charles H. Baldwin, Manager of the National Meter Co., Boston, Mass., has been elected President of the Franklin Savings Bank of Boston.

Mr. A. D. Furlong, General Superintendent and Electrical Engineer of the Springfield (Ill.) Consolidated Ry., has been appointed General Manager.

Mr. Lloyd B. Jones has been appointed Assistant Engineer of Motive Power of the Pennsylvania R.R. Lines West of Pittsburgh, with headquarters at Toledo, Ohio.

Mr. C. W. Akers, Trainmaster of the Seaboard Air Line Ry., at Plant City, Fla., has been appointed Superintendent of the Norfolk Southern R.R., at New Bern, N. C.

Messrs. Christopher H. Bierbaum and William M. Dollar, Ms. Am. Soc. M. E., announce the formation of Bierbaum-Dollar, Inc., with offices at 1142 Prudential Bldg., Buffalo, N. Y.

Mr. J. Bruce Ismay, President of the International Mercantile Marine Co., which controls the White Star Line, owners of the ill-fated "Titanic," has resigned, effective June 30.

Mr. Herman Hall, Division Engineer of the Louisiana Southern Ry., has been promoted to be General Superintendent, at New Orleans, La., succeeding Mr. W. H. De France, resigned.

Mr. A. L. Grandy has been appointed Chief Engineer of the Perre Marquette R.R., with headquarters at Detroit, Mich. Mr. Grandy was formerly Division Engineer at Saginaw, Mich.

Mr. R. C. Harris, Division Engineer of the Pennsylvania R.R. Lines West of Pittsburgh, at Akron, Ohio, has been promoted to be Supervising Engineer, attached to the staff of the General Superintendent at Columbus, Ohio.

Mr. G. C. Wilhelmi has announced the dissolution of the partnership of Wilhelmi & Smith, Cleveland, Ohio. Mr. Wilhelmi has opened an office at 810 Columbia Bldg., Cleveland, as a contractor and builder of engineering structures.

Mr. L. J. Ferritor, formerly Division Superintendent of the Chicago & Alton R.R., at Bloomington, Ill., has been appointed Superintendent of the Scranton division of the Delaware, Lackawanna & Western R.R., at Scranton, Penn.

Mr. J. J. McCullough, recently Inspector of Terminals of the Northern Pacific Ry., St. Paul, Minn., has been promoted to be Superintendent of the Puget Sound division, which includes the terminals at both Seattle and Tacoma, Wash.

Mr. C. S. Sheldon, Assoc. M. Am. Soc. C. E., recently First Assistant Engineer of the Cincinnati, Hamilton & Dayton Ry., Cincinnati, Ohio, has been appointed Engineer of Bridges and Structures of the Pere Marquette R.R., with headquarters at Detroit, Mich.

Mr. M. J. Kennelly, recently Division Superintendent of the Chicago, Rock Island & Pacific Ry., has been appointed General Manager of the Kansas City, Mexico & Orient Ry., succeeding Mr. Edward Dickinson. His headquarters will be at Kansas City, Mo.

Dr. Henry M. Payne, formerly Professor of mining engineering at the West Virginia University, and recently Mining and Metallurgical Expert with Stephen T. Williams & Staff, Inc., 50 Church St., New York City, has been appointed Chief of Staff of the company.

Mr. Harry A. Hyman has become associated with Mr. Marshall W. Brown, Assoc. Am. Soc. C. E., as Manager of the Waterproofing & Construction Co., 35 Wall St., New York City. Mr. Brown will continue his private practice as a consulting construction engineer.

Mr. John H. O'Neil, formerly connected with the American Museum of Natural History, New York City, and a graduate in sanitary engineering of the Massachusetts Institute of Technology, has been appointed Sanitary Engineer of the Louisiana State Board of Health.

Mr. H. E. Newcomet, Division Engineer of the Cleveland & Pittsburgh division of the Pennsylvania R.R. Lines West of Pittsburgh, at Cleveland, Ohio, has been appointed Superintendent of the Louisville division, with office at Louisville, Ky., succeeding Mr. F. J. Kron, promoted.

Mr. F. D. Batchellor, Division Engineer of Maintenance-of-Way, of the Baltimore & Ohio Southwestern Ry., at Seymour, Ind., has been promoted to be Assistant to the General Superintendent of the Baltimore & Ohio Southwestern and the Cincinnati, Hamilton & Dayton Rys., at Cincinnati, Ohio.

Mr. J. W. Eber, M. Am. Soc. C. E., has been promoted from the position of General Superintendent to that of General Manager of the Toronto, Hamilton & Buffalo Ry., at Hamilton, Ont. Mr. Eber was formerly Division Engineer and Division Superintendent of the New York Central & Hudson River R.R.

Mr. Franklin K. Lane, of California, a member of the Interstate Commerce Commission since 1905, has been elected by the commission, Chairman, for a term of one year. Mr. Lane is a Canadian by birth and a lawyer by profession. From 1897 to 1902, he was corporation counsel for the city of San Francisco, Calif.

Mr. A. Hussey, Assoc. Am. Inst. E. E., Supervisor of Transmission, in charge of the construction and maintenance of all the transmission facilities of the electric zone of the New York Central & Hudson River R.R., has resigned to become Acting Superintendent of Distribution of the Edison Electric Illuminating Co., of Brooklyn, N. Y.

Mr. H. A. Cassil, Division Engineer of the Cincinnati, Hamilton & Dayton Ry., at Indianapolis, Ind., has been appointed Division Engineer of the Baltimore & Ohio Southwestern Ry., at Seymour, Ind., succeeding Mr. F. D. Batchellor, promoted as noted elsewhere. Mr. H. F. Passel, Division Engineer of the Cincinnati, Hamilton & Dayton Ry., at Dayton, Ohio, succeeds Mr. Cassil at Indianapolis.

Mr. C. M. Garland, Assoc. Am. Soc. M. E., recently Engineer in charge of the gas-producer department of the Camden Iron Works, Camden, N. J., has become associated with the firm of Woodmansee, Davidson & Sessions, Consulting Engineers, First National Bank Bldg., Chicago, Ill. In addition to its present line of work the firm will take up consultation work in the design and operation of gas-plant and gas-power installations.

Mr. E. G. Connette, Assoc. Am. Inst. E. E., former Transportation Engineer of the Public Service Commission of the First District of New York, and recently Vice-President of the International Traction Co., Buffalo, N. Y., has been elected President of the International Railway Co., of Buffalo, succeeding Mr. Thomas Penny, resigned. Mr. Connette was formerly General Manager of the Worcester (Mass.) Consolidated Street Railway Co.

Mr. Charles H. Ewing, whose appointment as General Superintendent of the Philadelphia & Reading Ry., was noted in our issue of Jan. 2, began his railway career in the engineering department of this railway as a rodman in 1883. He was Chief Engineer of the Central New England R.R., now a part of the New York, New Haven & Hartford R.R., from 1894 to 1902. Afterward he was Division Engineer and Engineer of Maintenance-of-Way of the Philadelphia & Reading Ry.

Mr. Gano Dunn, F. Am. Inst. E. E., who has been Vice-President of J. G. White & Co., New York City, in charge of the engineering department, has been elected President of the J. G. White Engineering Corporation, a subsidiary of J. G. White & Co., Inc., which will handle the engineering and construction work. The operating department of J. G. White & Co. will be known as the J. G. White Management Corporation. Mr. J. G. White, M. Am. Soc. C. E., remains the President of the parent company.

Mr. Seely Dunn has been appointed Division Engineer of the United Fruit Co., with headquarters at New Orleans, La. Mr. Dunn's railway experience began in 1884 with the Louisville & Nashville R.R., as a stenographer. After passing through the several grades in the operating department to that of Division Superintendent, he became Vice-President and General Manager of several projected railway lines. His new position will consist chiefly of directing the improvements in the United Fruit Co.'s railway lines in Central American countries.

Mr. R. S. Parsons, M. Am. Soc. C. E., Superintendent of the New York division of the Erie R.R., at Jersey City, N. J., has been promoted to be Assistant General Manager of the lines east of Buffalo and Salamanca, with headquarters in New York City. Mr. Parsons graduated from Rutgers' College, in 1895, and has since been in service of the Erie R.R. He served in various positions in the engineering department, and for four years, 1901-1905, he was Engineer of Maintenance-of-Way. He has been Superintendent in the operating department since 1905.

Mr. C. S. Sergeant, Vice-President of the Boston Elevated Ry. Co., who has been chief of the bureau of operation of the company, has been made chief of the bureau of elevated and subway construction, succeeding the late George A. Kimball, M. Am. Soc. C. E. The Second Vice-President, Mr. Matthew C. Brush, has been made head of the department of transportation, power, inspection and employment; and Mr. C. Hile has become head of the department of maintenance, which includes mechanical and electrical engineering, maintenance of way, rolling stock, shops, wires and conduits, buildings and stores.

Mr. A. M. Schoyer, General Superintendent of the Northwestern system of the Pennsylvania R.R. Lines West of Pittsburgh, at Pittsburgh, Penn., has been promoted to be General Manager of the Vandalia R.R., at St. Louis, Mo., succeeding Mr. Benjamin McKeen, M. Am. Soc. C. E., promoted, as noted in our issue of last week. Mr. Schoyer entered the service of the Pennsylvania R.R., in 1872, at the age of 13 years as a messenger boy. He rose through the grades of telegraph operator, chief operator, train dispatcher, chief train dispatcher, to Superintendent of Telegraph of the Lines West of Pittsburgh, in 1892. In 1899, he became Superintendent of the Eastern division at Allegheny, Penn., and since 1902, he has been General Superintendent of the Northwest system.

OBITUARY

Samuel Barclay Charters, Jr., Assoc. Am. Inst. E. E., Assistant Professor of electrical engineering at Leland Stanford, Jr., University, in California, died at the home of his father in Pittsburgh, Penn., Dec. 29. A widow and young son survive him.

Eben Smith Wheeler, M. Am. Soc. C. E., United States Assistant Engineer at Detroit, Mich., died at his home in that city, Jan. 5. He was born in Wayne County, Penn., Aug. 27, 1839. He graduated in civil engineering at the University of Michigan in 1867. He at once entered the engineering service of the government and spent his entire lifetime as a civil engineer assistant to officers of the Corps of Engineers of the United States Army. His principal work was in connection with the Sault Ste. Marie Canal construction and as Chief Engineer of the Nicaragua Canal Commission of 1887. Mr. Wheeler was also connected for many years with the surveys of the Great Lakes.

ENGINEERING SOCIETIES

COMING MEETINGS

KANSAS ENGINEERING SOCIETY.
Jan. 21-22. Annual meeting at Topeka, Kansas. Secy., T. J. Strickler, Topeka, Kansas.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 21-23. Annual convention at Chicago, Ill. Secy., F. J. Angier, B. & O. R.R., Baltimore, Md.

OHIO ENGINEERING SOCIETY.
Jan, 21-23. Annual meeting at Columbus, O. Secy., C. J. Knisely, New Philadelphia, Ohio.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 21-23. Annual meeting at New York City. Secy., W. W. Macon, 29 West 39th St., New York.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 22-24. Annual meeting at Chicago, Ill. Secy. E. E. R. Tratman, 1144 Monadnock Block, Chicago, Ill.

INDIANA ENGINEERING SOCIETY.
Jan. 23-25. Annual meeting at Indianapolis, Ind. Secy., Charles Brossmann, Union Trust Building, Indianapolis, Ind.

SOCIETY OF CONSTRUCTORS OF FEDERAL BUILDINGS.
Jan. 23-25. Annual meeting at Washington, D. C. Secy., T. R. Maul, 4213 Westminster Ave., Philadelphia, Penn.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 28-30. Annual meeting at Montreal, Que. Secy., C. H. McLeod, 413 Dorchester St., West, Montreal.

NORTH DAKOTA SOCIETY OF ENGINEERS.
Feb. 13-14. Annual meeting at Bismarck, N. D. Secy., E. F. Chandler, University, N. D.

Central Railway Club—The following officers for 1913 were elected at the annual meeting of the club, on Jan. 9: President, W. F. Jones; Vice-Presidents, W. Elmer, H. C. Manchester, E. J. Devans; Executive Members, E. M. Tewkesbury, G. A. Bowman, E. P. Mooney. H. D. Vought was reappointed Secretary-Treasurer.

Western Society of Engineers—The society held its annual meeting, at Chicago, Jan. 8 and 9. At the annual dinner, held Jan. 8, at the Sherman Hotel, the principal addresses were by D. Emory R. Johnson (University of Pennsylvania) on "The Commercial Phases of the Panama Canal," and Charles H. Wacker, on "The Chicago Plan Commission." On Jan. 8, there was an excursion to the new Northwest power station of the Commonwealth Edison Co., where two vertical turbo-generator sets of 20,000 kw. each are now in operation, while the station is planned for a total development of 240,000 kw. A special train on the C. & N. W. Ry. was run up to the junction with the company's elevated third-rail railway, and was then hauled over this line to the power station by an electric locomotive. It is said that this was the first electrically hauled steam-railway train operated in Chicago. On Jan. 9, there was an excursion by the C. & A. R.R. to the plant of the Corn Products Refining Co., at Argo, 13 miles from Chicago. In the evening there was an informal meeting and entertainment at the Society's rooms. The officers for 1913 are as follows: President, Albert Reichmann (American Bridge Co.); Vice-Presidents, A. Bement, B. E. Grant and John F. Hayford; Treasurer, C. R. Dart; Secretary, J. H. Warder.

For the meetings on Jan. 20 and Jan. 27, the papers announced are "Concrete Roadways," by E. N. Hines (Detroit), and "The Regulation and Enforcement of Public Utility Laws," by Alfred Ericson (Wisconsin Railway Commission).

ENGINEERING LITERATURE

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EDITORIAL

An Engineer in "Fine Feathers"

Mr. Eugene Walter, we believe, has achieved considerable fame and no little lucre as a delineator of some of those phases of modern life which permit of dramatic presentation, and, as his characters and his episodes are taken from life, in the course of time it was to be expected that he would draw upon that field in which it is our pleasure and privilege to labor. From the current dramatic news we note that that time has arrived, and that the failure of a concrete dam with its attendant human frailties has been dramatized. So, although dramatic criticism is not precisely our metier, we consider a proper retaliation permissible.

The play referred to is entitled "Fine Feathers." It depicts through four acts the vicissitudes of an inspecting engineer (called a "chemist" in the play—and working for $25 per week), who, on account of the importunities of a luxury-loving wife, allows himself to be bribed into accepting for a huge dam an inferior cement, which will not pass the specifications. The tainted money only brings unhappiness, and in the end the dam fails, many people are killed, and the unfortunate man commits suicide.

The morals of the play are unimpeachable, but we do object to the crucial incident upon which the play is based. As realism is Mr. Walter's forte, we could wish that he had carried it to a legitimate limit. Passing over the obvious fact that $25 a week chemists do not have the say as to what cement shall be used on a large work—and it was a large work, a very large work, for the bribing contractor saved $200,000 by the use of the inferior cement—we present for our engineering readers the following analysis of the specious reasoning that convinced the reluctant hero to his fall. "Ordinary cement," argues his tempter, in effect "will easily last a hundred years. Such public works as this dam are rarely allowed to stand for twenty-five. Obviously, it is a great waste of money and a mistake of the supervising engineer to demand this expensive material for a structure that will be torn down before it is worn out. My cheaper cement will certainly last this quarter century. Let it through and it will be worth $40,000 to you." And this "chemist" is supposed to be a man of fundamental honesty who needed some potent argument to dissuade him from the straight path.

We wish Mr. Walter would forward us at once for publication the methods of tests or observations by which one can tell that one cement will form a concrete that disappears in 25 years, and that another will be good for a century.

After all, it is of small consequence, since men and their motives are the true subject of the dramatist's art; he can juggle facts as his fancy directs. Stage realism is an artificial sort of thing at best, only it is so rarely that we may wander in this particular field of criticism that we cannot let the opportunity pass.

REVIEWS

Roof Design and Construction

Reviewed by A. W. CARPENTER*

A TREATISE ON THE DESIGN AND CONSTRUCTION OF ROOFS—By N. Clifford Ricker, B. S., M. Arch., D. Arch.; Professor of Architecture, University of Illinois; President, Illinois Board of Examiners of Architects. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. xiii + 419; 644 text figures. $5, net (21/-, net).

According to the reviewer's interpretation of the author's preface, this book is intended primarily for the use of architectural students in preparing themselves for examination for license to practice. It covers the usual design of roofs, including definitions of parts, loads, methods of determining stresses and the determination of stresses in about all the known forms of roofs, proportioning of sections, calculation of dimensions, detailing and determination of weight.

Twenty-four examples of stresses in different forms of trusses and arches are worked out by graphic statics. These include the ordinary triangular forms, mansard, crescent and cantilever trusses, three-hinged arches and combination trusses and arches. In one chapter, 70 typical forms of roof trusses with accompanying stress diagrams are shown. While graphostatics is the method principally employed for the determination of stresses, the method of moments is also explained.

A chapter is devoted to the determination of the apex lengths of truss members, and another to the stability of walls and pressure on foundations. Axial stresses and shear are explained, but not the theory of bending and of resistances to bending in beams. Formulas for the strength and stiffness of beams are given. The formulas based on the maximum allowable deflection are unusual and commendable. The ton is employed as the unit of weight, which the

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author thinks renders the application of the formulas briefer and simpler.

Tables for proportioning members are provided. These are based on the working strength of different forms at usual uniform values per square inch of section. They cover the usual members, such as rods, channels and angles in pairs, latticed channels, wooden posts, rivets and pins. These tables make it possible to dispense with much of the customary reference to the hand-books of steel mills, but such reference is still required for the bending properties of steel shapes. A wooden roof and several types of steel roofs are worked out in detail for the dimensions of members, the details of joints and connections and the weights.

The reviewer would commend the book for the treatment of graphostatics; the multitude of examples and of types thus treated; the advocating of less severe conditions than the combining of maximum wind and snow-load stresses; the consideration of the stability of walls against wind loads and the pressure on foundations due to such loads; the introduction of stiffness as a fundamental factor in proportioning beams; the general clear and complete treatment.

The reviewer would find fault with the following: The form of splices for timber advocated are the short halved-and-bolted splice for compression and the steel fishplate splice for tension; these are unquestionably good splices if properly made but the difficulties of workmanship are not stated and apparently are not appreciated. In the formulas for proportioning the tension splices, no account of the bending in bolts is taken—a very serious omission. The use of single angles for the truss members is pronounced bad practice, and the use of such members is carefully excluded from all the examples. While admitting the preference of double angles for members, the reviewer believes their use may be extravagant where single angles provide sufficient or excess strength. Since such members have been successfully employed in railroad bridges they should not be barred from roof trusses. The analysis of stresses in the example of an octagonal hip roof with lantern seems to neglect the thrusts due to the hip rafters and the axial wind stresses. The chapter on lengths of truss members involves much repetition of exceedingly elementary work. In treating the pressure on foundation due to combined vertical and wind loads the point of application of the horizontal force is taken at the top of the foundation, whereas in treating the steel columns the point of application is taken half way to the knee brace connection. The examples of footings 1.5 to 2 ft. deep are impractical for cold climates where they should extend below frost and be more nearly double the depth mentioned. The reviewer never before heard of proportioning a beam for the maximum bending moment and then increasing the section to compensate for the portion of the web required to resist the shear, as is done in an example, and he cannot agree to the statement that longitudinal shear occurs only in wooden beams, and he does not understand why logarithm tables should be recommended for labor- and time-saving where a slide rule is obviously the practical tool. The longitudinal component described in inclined beams with vertical end supports does not exist for vertical loads within the span.

The book is essentially academic and largely elementary, the detail designs illustrated being painfully so. One trouble with the designs is the fanatical adherence to clip-angle additions to all angle connections which, together with the taboo on single-angle members, makes the trusses ugly and extravagant of material.

The tables of working strength of two-angle struts give different values according to the method of connection. For unequal-leg angles three sets of values are given, these being, respectively, for the cases of: (1) Narrow leg riveted, (2) wide leg riveted, (3) both legs riveted (clip-angle connections). The relative values assigned are in the proportions of about 40:60:95; that is, a double-angle strut with the wide legs of angles connected to the gusset would be allowed to carry $^{95}/_{60}$ as much load if clip-angles were added to connect the other legs. The reviewer believes these proportions entirely erroneous and to lead to unnecessary expense. On the other hand the author freely employs members as thin as $\frac{5}{16}$ in. It seems too bad that better and more consistent practice in proportioning and detailing is not presented in this book, which will no doubt form the guide for many young architects and engineers.

There are a multitude of minor errors of all kinds throughout the book.

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The new quarters of the Ohio State Board of Health are described and illustrated with the floor plans and halftones in the December "Bulletin" of the Board. Two floors of the Hartman Building, Columbus, Ohio, are used.

The Entropy Temperature Diagram

Reviewed by L. S. MARKS*

CALCULATIONS ON THE ENTROPY-TEMPERATURE CHART—By W. J. Crawford, D. Sc., Lecturer in Mechanical Engineering, The Municipal and Technical Institute, Belfast; author of "Graphic Statics." London: Charles Griffin & Co., Ltd. Philadelphia: J. B. Lippincott Co. Cloth; 5x8 in.; pp. viii + 74; 52 text illustrations.

The general character and scope of this book are sufficiently indicated in the following extracts from its preface:

My object in writing this little book is to show students who are not very well up in thermodynamics how to make use of the entropy-temperature chart. For this purpose I have treated the matter as simply as possible, and have not insisted on a first-rate knowledge of the principles underlying entropy as the indispensable outfit for the purpose in hand. * * * * *

It is much better to teach a student how to make calculations on the chart than to be eternally drilling him in the abstract mathmetical principles involved. * * *

My hope is that this little volume will be of use to those who would like to learn how to use the chart but who have never been able to find the information in a sufficiently simple form. Therefore, I have introduced a large number of examples, and have worked many of these out at length.

The author lives up to his promise, but proceeds further in his use of the entropy-temperature diagram than is likely to be of any service to such students as those whom he has in mind. It is not easy to understand why the book is devoted exclusively to the entropy-temperature chart and fails to make any mention of the essentially similar, but much more useful entropy-total heat, or Mollier chart. Like so many English works of its class, it appears to be suggested by and aimed at the examinations of the British Board of Education.

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ENGINEERING AND METALLURGICAL BOOKS, 1907-1911—A Full Title Catalog, Arranged under Subject Headings, of All British and American Books on Engineering, Metallurgy and Allied Topics, Published During the Five Years 1907-1911, with Their English and American Prices and Publishers' Names. By R. A. Peddie, Author of "Metallurgical Bibliography, 1901-1906," "National Bibliographies," etc., and Joint Editor of "The English Catalogue of Books, 1801-1836." New York: D. Van Nostrand Co. Cloth; 5x7½ in.; pp. ix + 244. $1.50, net.

A bibliography of good engineering or of good metallurgical books, with brief but pithy descriptive and critical notes, would be a real boon to the earnest searcher for technical data and information. The book before us is far from being such a work. As the author states, this bibliography is a "full title catalog" only—based on publishers' statements. He further states that he has brought together "all the discoverable titles," including many books that the publishers "had failed to notify the public they had published." Our readers who are familiar with present and ever increasing flood of mediocre (and worse) technical books, on even the most minute subjects, may wish more of the list had been undiscoverable.

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GASOLINE ENGINES: THEIR OPERATION, USE AND CARE—A Comprehensive, Simple and Practical Work, Treating of Gasoline Engines for Stationary, Marine or Vehicle Use. Containing also a Complete Table of Motor Troubles and Remedies and a Full Glossary of Technical Terms Used in Connection with Gasoline Engines. By A. Hyatt Verrill. New York: The Norman W. Henley Publishing Co. Cloth; 5x7½ in.; pp. 275; 152 text illustrations. $1.50.

The difference between 2-cycle and 4-cycle gasoline engines, as to structural features and operating characteristics, is brought out by the author in language which has evidently been made as simple and non-technical as possible in order to reach that large number of gasoline motor operators and repair-shop men whose knowledge of technical terms is limited. Such technical words as it was impossible to avoid using are explained in a glossary at the end of the book.

The feature of the book is a list of common gasoline motor troubles, causes and remedies, but a good deal of attention is paid to the subject of valve operation and to oiling, cooling, and ignition systems and a number of practical suggestions for minor repair work are given.

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DIARY OF A ROUND-HOUSE FOREMAN—By T. S. Reilly, Late Associate Editor of "Railway Review." New York: The Norman W. Henley Publishing Co. Cloth; 5x7 in.; pp. 158. $1, net.

The author has succeeded admirably well in telling the story of a young mechanical engineer's start in the railway service and the reasons for his subsequent success. Any engineer who has or expects to have an executive position

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where he will be called upon to direct the work of laborers, skilled or unskilled, will find many useful hints and valuable suggestions. Aside from these, the "diary" is so entertaining that one may read it merely for pleasure and be well repaid.

Translation of a German Work on Explosives

Reviewed by CLARENCE HALL*

EXPLOSIVES—A Synoptic and Critical Treatment of the Literature of the Subject as Gathered from Various Sources. By Dr. H. Brunswig. Translated and Annotated by Charles E. Munroe, Ph. D., LL.D., and Alton L. Kibler, M. S., Ph.D., George Washington University. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¼x8¼ in.; pp. xv + 350. $3. net.

The author treats of the literature of explosives as gathered from reliable sources and considers the application of physical chemistry to the technique of explosives. Many references are made to the experiments and scientific researches of Berthelot and Abel; also to the more recent investigations of van't Hoff, le Chatelier, Bichel, Sarran, Will, and Nernst.

The presentation of the detailed results of many experimental tests in connection with the conclusions drawn therefrom is in striking contrast to the procedure followed in the English literature of explosives in which the experimental proof is often omitted. As a whole the book may be considered a valuable contribution to the literature of explosives and a reliable book of reference. A few discrepancies are noted and certain statements made not in accordance with the facts. Fortunately the translators were thoroughly familiar with the subject at hand and the annotations made by them add materially to the value of the work.

The conditions governing explosive reactions are treated: (1) In respect to thermo-chemical laws; (2) the characteristic sensitiveness of different explosive systems; and (3) the initiation of the reaction by means of flame, impact, detonators, and the transmission of an impulse (influence).

It is stated in the discussion of Table 4 "Energy Content of an Explosive System Expressed as Heat of Explosion (Calories)" that the heats of explosion, as expressed for the technically important explosives, do not show the comparative worth of explosives in practice, but that the heats of explosion may be regarded as a measure of relative efficiency in the case of those explosives standing near each other in the table because their technical use is similar.

The reviewer takes exception to this statement because it has been shown in mining practice that the efficiency of even those explosives whose technical use is similar cannot be measured by the heats of explosion. As an example, the first two explosives given in the table show that explosive gelatin has a value of 4% more than nitroglycerin. This relation is not consistent with general practice. In shooting oil wells or in other similar work explosive gelatin has not been found as efficient or as economical in replacing nitroglycerin, but the many advantages of explosive gelatin with respect to increased safety in transportation and handling more than compensates for the increased expense involved in its use. In the table 75% nitroglycerin dynamite and 40% nitroglycerin dynamite is given the same value: namely, 79%; and picric acid is given a value of 49% as compared to 41% for black blasting powder. It is evident from the results of tests made by the reviewer† that the relation of efficiency given in this table is not applicable to the technical use of explosives. The heats of explosion represent the potential energy or the maximum work that an explosive can theoretically accomplish. But as the useful work resulting from the use of explosives is a small percentage of the theoretical maximum, and as it varies considerably with the different types of explosives, knowledge of the potential energy of explosives is of little value to the user of explosives. Furthermore, the useful work resulting from explosives depends on the material to be blasted and the method of application. On account of the varying conditions in blasting, certain characteristics of an explosive may be of much importance in certain classes of work, and of little or no importance in others.

The initial velocity and rate of propagation of explosive reactions as influenced by temperature, pressure, and catalytic influences are given for inflammable gas mixtures and explosive compounds. The different methods and kinds of apparatus used in determining the velocity of explosive reactions are described. The steel bomb used by P. Vielle in determining the velocity of the combustion of various powders, Dixon's device for determining the velocity of the explosive wave of gaseous mixtures, and Mettegang's recorder similar to that used by the U. S. Bureau of Mines for determining the rate of detonation of explosives, are mentioned.

In treating the subject of pressure in explosive transformations the significance of the rate of detonation, as determined for a few inflammable gas mixtures and explosives when compared with results obtained by empirical methods for measuring their brisance (shattering effect), would indicate that there does not exist a close agreement between the rate of detonation of a given explosive and the brisant effect produced by its explosion. However, it is the opinion of the reviewer that from the results of physical tests made and observations in actual mining operations in the United States a very close agreement does exist between the rate of detonation of commercial explosives and the shattering effects produced. Furthermore, it has been found that the rate of detonation is the govering factor in selecting explosives suitable for the work. Thus, in hard rock blasting operations in which a shattering effect is desired, the explosive reaction should be quick and explosives having a high rate of detonation are selected. The higher the rate of detonation of commercial explosives the less the amount of heat loss by the products of combustion through radiation and conduction, and accordingly the more violent the effect it will exert.

The well known empirical tests are described for determining the brisance of explosives, such as small lead blocks and Trauzl lead blocks which are used by the U. S. Bureau of Mines for determining the disruptive effect of explosives. The lead plate tests for determining the relative strength of detonators could have been omitted with advantage. This test has been frequently described in textbooks on explosions. It consists of exploding the detonator on a lead plate which rests on an iron ring. The strength of the detonator is measured by the deformation or the penetration of the block and the fine radiating marks produced upon the surface of the plates. Tests recently completed by the U. S. Bureau of Mines show that this test does not indicate the relative effectiveness of different grades of detonators in initiating the explosive reaction of the commercial explosives used in this country.

A chapter is devoted to the temperature of explosion and also one to the gases evolved on explosive reactions. The method used in France and Spain is given for calculating the theoretical temperature of explosion from the data obtained from the analysis of the original explosive and that of the resulting products, also the method of direct determination by firing an explosive in a calorimetric bomb. However, nothing new is presented governing the specific heats of the products of explosion at high temperatures and, accordingly, the temperature to which the heat of explosion will raise the products of combustion cannot yet be accurately determined. The influence of the density of loading upon the composition of the gases resulting from the explosion of explosive compounds is considered and typical analyses of the gases from the explosion of nitrocellulose and picric acid under varying pressures are given.

In considering the subject of explosions by influence the author states it is still an open question whether the phenomenon is due to the rapidly increasing pressure of gases developed with great velocity or simply a phenomenon accompanying the high temperature. Attention is called to the late investigations which indicate the formation of a wave movement that originates in the sudden disturbance of equilibrium and communicates to the surrounding medium. The application of the phenomena as shown in the practical use of explosives is of special interest.

In the chapter on the flame of an explosive it is shown that the degree of safety of an explosive toward fire damp and coal dust in blasting work depends principally on the character of the flame accompanying its explosion. A description is given of the experimental mine station in Gelsenkirchen and Bichel's apparatus for determining the length and duration of the flame of an explosive. The characteristics of explosives, including igniters, fuse and detonators, are cited, and their practical significance with respect to the density, hygroscopicity and stability.

The book closes with a chapter on Blasting Explosives. The methods of manufacturing the more important commercial explosives, such as nitroglycerin, nitrocellulose, nitrated aromatic compounds, dynamites, black blasting powder, and permitted explosives are given; also the foreign regulations are cited with reference to the manufacture of explosives and suggestions given concerning the handling, application and destruction of explosives.

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†See U. S. Bureau of Mines Bulletin 48.

New Editions of Tillson's Pavements and Spalding's Roads and Pavements

STREET PAVEMENTS AND PAVING MATERIALS—A Manual of City Pavements: The Methods and Materials of Their Construction. By George W. Tillson, C. E., Consulting Engineer to the Borough President of Brooklyn, City of New York. Second edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. xii + 651; 97 text figures. $4, net (17/- net).

A TEXT-BOOK ON ROADS AND PAVEMENTS—By Frederick P. Spalding, Professor of Civil Engineering, University of Missouri; M. Am. Soc. C. E. Fourth edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x7 in.; xii + 408; 51 text figures. $2, net (8/6, net).

In noticing Mr. Tillson's "Pavements in our issue of Jan. 10, 1901 (p. 32), we gave it such commendation as left nothing further of the kind to be said of a subsequent edition, except as regards the thoroughness of revision. As to the latter, the author seems to have been uncommonly faithful, particularly in major particulars. Frequent references are made to the recent proceedings of the Association for Standardizing Specifications and of the American Society for Municipal Improvements, and statistical and other data for 1912 are found at various points in the new edition.

Two new chapters appear: "Concrete Pavements" and "The Protection of Pavements." Of the 30 pages on concrete pavements over half are occupied by a reprint of the American Society of Civil Engineers' specifications for portland cement, and much of what is left consists of extracts from the specifications and trade circulars of promoters of proprietary concrete pavements. The chapter (28 pages) on protecting pavements, while also composed largely of reprinted matter, is a valuable addition to the book. The new edition contains 119 pages more than did the first one, including the space occupied by 37 additional illustrations.

For the benefit of the younger readers of these columns it may be stated that Mr. Tillson writes from a long experience as engineer in charge of paving work in Brooklyn, and later in Manhattan borough, New York City. Engineering literature would gain if more engineers would give the profession the value of their world-wide investigations and their personal experiences in their special fields of work, as has been done so unstintingly by Mr. Tillson.

Prof. Spalding produced a small textbook on both roads and pavements as far back as 1894, and has performed the duty of revision now for the fourth time. His revision of 1908, which was largely a rewriting, was so well done that Samuel Whinery, reviewing the third edition in our issue of Dec. 17, 1908, characterized the volume as the best elementary textbook on roads and pavements yet produced—although earlier in the review he called attention to the almost inevitable limitations of new editions of technical books.

In the present edition the author has added chapters on bituminous macadam and concrete pavements and has "considerably modified" the chapters on brick, asphalt and wood pavements, effecting a gain of 68 pages, or 20% in space. Considering the breadth of his field and his space limits, the author continues to do well in his endeavor to cover roads and pavements in a single volume.

The full table of contents goes a very small ways in justifying the omission of an index.

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An Elementary Text on Mechanism

Reviewed by JOHN J. FLATHER*

MECHANISM—By Robert McArdle Keown, B.S., Assistant Professor of Machine Design, University of Wisconsin. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. 169; 168 text figures. $2, net.

This work has been written as a college textbook and is intended to cover an elementary treatment of the subject extending throughout one-half year of study which embraces one lecture, one recitation and four hours' drafting work per week.

After a brief discussion of motions and velocities in general, the subject of linkages is presented. This is followed by a study of cams, gearing, and intermittent motions. Numerous problems are given at the end of each chapter; those which relate to the drafting room work are presented with especial reference to the needs of the student and are accompanied with all necessary instructions for laying out the mechanism. This feature ought to save considerable time on the part of both student and instructor.

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It is to be regretted that on the first page of the book, the greatest authority on the subject of Kinematics should have his name spelled "Realeaux." This is followed by a rather loose statement relating to the design of machines in which it is stated that "the general outline is sketched without any regard to the detailed proportions of the individual part, and from this sketch or skeleton, acceleration of each of the moving parts can usually be accurately determined." Of course the author intends to say that the general outline may be sketched and the displacement and velocities determined if certain dimensions or proportions be given; without taking into account all the various dimensions of a piece.

The present reviewer would prefer to retain the use of the words "instantaneous center" as given by Reuleaux, rather than use the word "centro" which the author has adopted, even though the latter be briefer.

In the chapter on Cams the author devotes some 28 pages to the consideration of this subject, in which the principal types are represented very concisely and clearly. Under Gearing there appears the unusual discussion of friction gearing, involute and cycloidal, bevel and worm gears, with a description of the methods used in developing and cutting same. Elliptical gears are rather briefly treated and epicyclic trains are omitted entirely.

A perusal of the book indicates that it has been prepared with especial reference to the needs of the author's classes as a preparation for the more advanced work in machine design. The subject matter is essentially the same as that Gearing there appears the usual discussion of friction treatise of this character prepared for a special purpose, it is to be expected that many of the topics included should be discussed only briefly and that some rather important parts of the subject should be omitted entirely. However, the arrangement and method of treatment of the topics presented ought to produce excellent results if accompanied by the exercises required to be worked out in the drafting room.

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A TEXT-BOOK OF PHYSICS—Contributors, A. Wilmer Duff, E. Percival Lewis, Charles E. Mendenhall, Albert P. Carman, R. K. McClung and William Hallock. Edited by A. Wilmer Duff, D. Sc., Professor of Physics, Worcester Polytechnic Institute, Worcester, Mass., Third edition, revised. Philadelphia: P. Blackiston's Son & Co. Cloth; 5½x8½ in.; pp. 686; 595 text illustrations.

The third edition shows many changes over the second and decided contrast with the first. The type is new and the division of text between large and small type (to show essential from only desirable parts of a course) is modified. There is some space saved in remaking the illustrations together with an improvement in appearance—though the old figures were not bad. In the second edition a section on "Wave Motion" by E. P. Lewis of the University of California replaced that by William Hallock of Columbia University. In this third edition, a section on "Heat" by C. E. Menden hall of the University of Wisconsin replaces that by K. E. Guthe of the University of Iowa; "Electricity and Magnetism" by A. W. Goodspeed of the University of Pennsylvania and "Electro-magnetic Induction" by A P. Carman of the University of Illinois, are covered by the latter author in a section, "Electricity and Magnetism."

The order of presentation has been changed, from mechanics, heat, wave motion, sound, light, electricity and magnetism, electro-magnetic induction, gaseous conduction and radioactivity, to mechanics, wave motion, heat, electricity and magnetism, gaseous conduction and radioactivity, sound, light. The changes seem to have been well considered and carefully made so that the book retains its previous balance and usefulness as a teaching text.

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STATE ROADS COMMISSION OF MARYLAND—Reports for 1908, 1909, 1910 and 1911. (E. E. Goslin, Secretary, Baltimore, Md.) Cloth; 6¾x10¼ in.; pp. 183; 12 page plates and one folding map.

The major part of this volume is occupied by the report of W. W. Crosby, chief engineer to the commission. Valuable tables of cost are presented by Mr. Crosby and also a system of road accounting designed for general use throughout the country. The chief engineer politely, but emphatically, criticises the Commission for laying out far more road construction than was warranted by the funds at its command, for adopting methods not approved by him, and for permitting the chairman of the commission to usurp the functions of its chief engineer, virtually making of the latter a consulting engineer. Attention is also called to the underpay of the engineering force, which (perhaps combined with the attitude of the commission in other matters) led no less than 60 engineers to resign their positions within a few years. Since the report was made the chief engineer has also resigned.

New Highway Literature

Reviewed by A. W. DEAN*

HANDBOOK FOR HIGHWAY ENGINEERS—Part I. Theory of Design. Part II. Practice of Design and Construction. By Wilson G. Harger, C. E., First Assistant Engineer, New York State Department of Highways; Assoc. M. Am. Soc. C. E., and Edmund A. Bonney, Chief Draftsman, Division No. 5, New York State Department of Highways. New York and London: McGraw-Hill Book Co. Leather; 4x7 in.; pp. 493; 74 text figures; 67 tables. $3, net.

MODERN ROAD CONSTRUCTION—A Practical Treatise for the Use of Engineers, Students, Members of Local Authorities, Etc. By Francis Wood, M. Inst. C. E., F. G. S., Borough Surveyor of Fulham [England]; Author of "Practical Sanitary Engineering." London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 5¼x8 in.; pp. xi + 137; two folding plates and 25 text figures. $1.50, net.

ROADS, PATHS AND BRIDGES—By Logan Waller Page, Director, United States Office of Public Roads; President, American Association for Highway Improvement; M. Am. Soc. C. E. New York: Sturgis & Walton Co. Cloth; 5x7½ in.; pp. 263; illustrated. 75c., net; postpaid, 84c.

The authors of the new highway handbook state in their preface that the purpose of the book is to collect in a compact and convenient form information ordinarily required in the field and office practice of road design and construction. A careful persual of the book shows it to be a compilation of data and tables, interspersed with information gained through the observation and experience of the authors on New York state highway work.

The first chapter discusses grades and alignments, giving tables showing maximum grades and widths constructed in states and countries that have adopted maximum or ruling grades. This is followed by a chapter devoted to different types of cross-sections. The authors here give illustrations representing standard cross-sections, principally of New York and Massachusetts, with a discussion of conditions governing the selection of proper width and section.

Drainage is treated in the third chapter, run-off, velocity and flowage tables and formula being given, together with plates showing standard reinforced culverts and small bridges, with accompanying tables of quantities and material entering into their construction as compiled by the New York State highway department, also data and tables concerning steel bars and other reinforcements.

The average road engineer would be somewhat confused in studying the chapter on foundations, as the authors do not differentiate between the foundation and the first course of road surface or crust. A short chapter is devoted to top courses. The authors state that "any discussion at this time of the methods of construction of the newer types of surfacing would be of little permanent value. . . . . Any conclusions which may be adopted are liable to be modified by further observation. . . . ." Some concise data and some positive statements are given, however, covering different types of surface, and giving some costs and results which the authors state in a concluding paragraph are only approximate and comparative.

A short chapter is devoted to qualities and physical characteristics of materials used in road construction. The subject is treated briefly and rather incompletely.

Part two of the book opens with a chapter on surveying practice, followed by a chapter on office practice. Both chapters are very clear and show in detail engineering field and office methods of designing work, calculating curves and quantities preparatory to make final specifications.

Cost data and estimates (many of which were contributed by one of the authors in 1911, to the "Engineering News") are given in much detail in Chapter 10. These data cover many of the details of state road construction, and, as the authors state, they must, although valuable, be used with discretion.

Chapter 11 consists of notes on construction, being essentially a chapter of directions and information for field inspectors. New York State specifications are given in Chapter 12, covering various materials and methods used by the New York state highway department.

The authors have also caused to be inserted in the book various tables, such as sines, tangents, logarithms, etc., commonly used in calculations.

One cannot but be impressed many times when reading the book with the fact that the experience of the authors was somewhat local. Two particular instances might be cited. The authors at one place state that vitrified clay pipe should never be placed under the roadbed proper unless incased in concrete. This advice is perfectly proper in the predominating soils of New York State, whereas in other soils double-strength vitrified clay pipe is perfectly satisfactory. The authors also classify broken stone as No. 1, 2, 3, etc. This is misleading, as the classification used in New York is different from that in some other states.

Notwithstanding the above criticisms, the book is one of value to road engineers and particularly to engineers employed on state highway work in the State of New York as a text and reference book.

In "Modern Road Construction," the author, as he states in his preface, has given in a concise and not too highly technical form, the leading characteristics and details of modern roads as observed by him in his experience in road construction. After a general introduction and a discussion of the wear on different types of roads due to natural causes and as affected by traffic, the author devotes the greater portion of the book to bituminous road construction.

This discussion is made up principally of notes taken by the author on road construction, repair and maintenance over quite a period of years, and as the notes are largely a result of his own practical experience and observation, the highway engineer will find them of considerable value. The author goes into considerable detail in describing bitumen and its application to road construction, not only as a blanket treatment, but also when incorporated in the road surface. Several pages are devoted to tests and analyses of bitumen and to comparisons of the results obtained by the use of different kinds of bitumens in road construction. A few pages are devoted to costs, but the cost data in the book can hardly be utilized by American engineers, as insufficient data are given of the rate paid per hour for labor and of the cost of material.

In the appendices are given typical specifications for constructing streets of macadam and wood pavement, and the specifications of the road board of England for surface tarring, and surfacing with pitch-grouted macadam, also extracts from the road board's specfications for tar and pitch. The book is well indexed, and is very clearly worded, making it interesting and very convenient for reference.

The layman or farmer will find in Mr. Page's "Roads, Paths and Bridges," a large amount of valuable information, set forth in an unusually clear manner, and made doubly interesting by many illustrations. The book opens with a brief history of road building and comments on road legislation. The author describes methods of construction and maintenance of the various types of roads and paths that are adapted to rural communities, with suggestions and advice governing the selection of materials and treatment of roadsides. A chapter on modern road problems treats briefly of the effect of automobile traffic and the use of oils and other dust layers. Culverts and bridges are treated by the author, the information given being of a descriptive rather than a technical nature.

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MECHANICAL ENGINEERING LABORATORY MANUAL—By Earl B. Smith, M. E.; Assistant Professor of Experimental Mechanical Engineering, Drexel Institute. Second Edition. Philadelphia: The Drexel Institute Press. Cloth; 6x9¼ in.; pp. iv + 92; 17 text figures. $2, postpaid.

This book is one of that already large and ever increasing number, which are built up from teachers' mimeographed syllabi, altered to make them as general as possible and still be definite enough to fit the detailed instruction given at one institution and, in this case, to the laboratory equipment of a given period. The author has recognized the difficulty of making such a manual of wide service. Presumably the book has been published chiefly to meet local demands—supplemented perhaps by a lesser call from other teachers.

The text covers most of what is generally taught to third-year students of mechanical and electrical engineering in the mechanical-power laboratory. It is designed to give them a ready familiarity with steam engines and boilers, piping systems, traps, separators, condensers, gages, calorimeters, indicators, dynamometers, gas engines, governors, carbureters, hydraulic motors, pumps, rams, orifices, weirs, meters, etc. Tests of working conditions, operating characteristics and efficiency of performance for all such machinery are planned with hints on the preparation of proper reports.

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The use of steel conduits for carrying all sorts of electric service wires is increasing in all kinds of building construction and naturally practice has ranged variously between the use of too small diameters for easy pulling in and use of extravagantly large sizes. To show the desirable intermediate sizes for any case the National Electrical Contractors' Association has prepared charts and tables giving the necessary data in detail.

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The charts show cross-sections of all sizes of conduit with various arrangements of conductors in place; the external diameter of conduit and carrying capacity of wires is also shown. The complete set of charts shows proper sizes of conduit for one-, two-, three- and four-wire systems; combination of duplex wires in sizes Nos. 10, 12 and 14; combinations of up to 90 single wires in No. 14; combinations of up to 150 fixture wires in Nos. 16 and 18, and combinations of up to 50 pairs of telephone wires. Each chart is mounted on heavy cardboard with an eyelet for hanging. They can be obtained from W. H. Morton, Secretary of the National Electrical Contractors' Association, 41 Martin Bldg., Utica, N. Y., at $2.25 per set.

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A Second Edition of the American Civil Engineers' Pocket Book

AMERICAN CIVIL ENGINEERS' POCKET BOOK.—Mansfield Merriman, Editor-in-Chief. Second edition, enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Montreal: Renouf Publishing Co. Morocco; 4x7¾ in.; pp. viii + 1473; 1200 text illustrations; 500 tables. $5, net. (21s., net).

That the first edition of the new engineering handbook prepared two years ago under Prof. Merriman's supervision* is now in its second edition and its 15th thousand demonstrates that the work was received eagerly and favorably. Such a reception, of course, warrants patient and careful efforts at revision, to correct errors and weak spots and to keep abreast of new developments. The future growth of the handbook will therefore be watched with interest by all who depend on such useful aids, which is to say all engineers.

The revision for the present second edition represents a change in some elements of the original plan, but leaves the bulk of the text unaltered. A chapter on Thermodynamics and Electricity, and a chapter on Highways and Streets, have been added, the latter being by Prof. A. H. Blanchard and the former by Prof. G. A. Goodenough and F. M. Farmer. Through these additions, two of the other chapters were improved by confining them to more circumscribed subjects; e.g., Railroads is now no longer burdened by mixture with Roads.

A certain amount has also been done in the way of minor revision. However, of the several comments made in our review of the first edition, a large proportion still apply, and (it is hardly necessary to add) the general description and characterization hold unchanged.

The two new chapters were placed at the end of the book, following "Physics, Meteorology, Weights and Measures." Section 13, while headed "Steam and Electric Engineering," deals in the former subject only with thermodynamics, of which Prof. Goodenough presents a very good summary. The Editor prefaces the section with a cautionary statement, that the section is "for civil engineers whose knowledge of the subjects is limited." Whether readers of this class will draw much instruction from even this edition's explanation of entropy will be for the future to show. They will welcome the notes on engine performance, but will miss other matter on engines. The restriction of the section to thermodynamics means, of course, that engines and pumps, etc., are not described. Under the heading "Electricity" the information is excellently practical, and it will throughout give sound and simple notions of electrical fundamentals, apparatus and fitting. A little further filing down may be helpful; to cite one of the most trivial illustrations, the statement relating to "Osmium, osram and zirconium lamps, . . . in which the filaments are of the metals indicated," may deserve to have "mazda" included.

Prof. Blanchard's chapter on streets and roads gives the impression of being fully uptodate and closely fitted to the probable demands of the reader of the pocketbook. All phases of the subject are covered, down to maintenance methods, construction plant and street cleaning. By the addition of this chapter the book has been notably improved.

The full evolution of such a handbook as this one is the work of many years, not one or two, and calls for the most scrupulous accuracy. To an author it may seem trifling indeed that two different figures are given for the weight of ashes; to the user of the book, who looks up its figures for the purpose of serious calculations, such a discrepancy may mean everything. Perhaps in that case the fact that before reaching this point he has been misled by the index heading "Ashes" into scrutinizing a table containing something on ash lumber, will seem like adding insult to injury. With many thousands of items making up the sum-total of the book, a patient fine-combing process, lasting over a long time, must be depended on for gradual elimination of error. The result will warrant such patience.

*The first edition was fully reviewed in our issue of Feb. 16, 1911, pp. 19-22.

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Spring Valley's Reply in the Hetch Hetchy Controversy

THE FUTURE WATER-SUPPLY OF SAN FRANCISCO FROM THE CONSERVATION AND USE OF ITS PRESENT RESOURCES—Report to the Honorable the Secretary of the Interior and the Advisory Board of Engineers of the United States Army. San Francisco: [Spring Valley Water Co.]. Cloth; 8½x11¼ in.; pp. x + 506; illustrated.

REPORT ON THE WATER-SUPPLY SYSTEM OF THE SPRING VALLEY WATER CO., San Francisco, Calif.—By H. M. Chittenden, Brigadier General, U. S. A. (Ret.), M. Am. Soc. C. E., and A. O. Powell, M. A. Soc. C. E. San Francisco: [Spring Valley Water Co.]. Cloth; 8½x11¼ in.; pp. 44; illustrated.

The latest addition to the already long list of reports and legal documents on the attempts of San Francisco to achieve municipal ownership of water-works and on its yearly conflicts over water rates takes the form of two handsome volumes of interesting reports to the Secretary of the Interior. Like the large report by John R. Freeman and others, noted briefly on p. 937 of our issue of Nov. 14, 1912, and abstracted at length in our issue of Dec. 26, 1912, the volumes before us are the product of the controversy over San Francisco's project to introduce a gravity water-supply from the headwaters of the Tuolumne River. This scheme involves the flooding of the Hetch Hetchy Valley, a cliff-surrounded mountain meadow, lying in the Yosemite National Park, some 20 or 25 miles from the Yosemite Valley; hence the jurisdiction of the Secretary of the Interior. The park defenders, as well as those who oppose the Hetch Hetchy project for commercial reasons, claim that there are plenty of other available sources of water-supply for San Francisco. Strongest among these claimants, naturally enough, is the Spring Valley Water Co., which supplies water to San Francisco.

The company just named was asked by the Secretary of the Interior, on May 28, 1912, to submit information on the adequacy of the property of the company to supply San Francisco with an ample water-supply in the future. This the company did under date of Oct. 31, 1912, in the form of a main report by F. C. Herrmann, its chief engineer, and numerous supplementary reports.

Briefly, Mr. Herrmann claims that his company "has secured water resources for the people of San Francisco that when completely developed will safely produce year in and year out 210 M. G. D., or over five and one-half times the present needs of the city. In addition to this, other sources have been secured, which may be depended upon to supply 42 M. G. D., for use within the proposed metropolitan district, making a grand total of 252 M. G. D."

The two volumes before us are devoted to engineering and geological data to support this thesis, with sections here and there aimed at criticisms of the company's supply. Among the reports included in the larger volume are these: Hermann Schussler, for many years chief engineer of the Spring Valley Water Co., on the present works and proposed extensions of the company; Wm. B. Mulholland and J. B. Lippincott, of Los Angeles, on underground waters; Geo. G. Anderson, of Denver, on rainfall and runoff; Prof. J. C. Branner, of Stanford University, and Prof. A. C. Lawson, of the University of California, on geological questions, particularly those pertaining to underground supplies: L. J. Le Conte, of Berkeley, Calif., on testing models of dams; and T. W. Espy, an engineer of the company, on theoretical phases of stream and weir discharge computations and on evaporation. The reports of Messrs. Mulholland, Lippincott, Branner and Lawson deal with alleged "erroneous conclusions," drawn by John R. Freeman regarding the underground sources of supply held by the company.

The smaller of the two volumes, by Gen. Chittenden and Mr. Powell, contains a review of the reports in the larger volume, with which are interspersed various criticisms of the Freeman report, mentioned at the beginning of this notice.

We do not envy Secretary Fisher's task of weighing the evidence presented in these and in Mr. Freeman's report, together with the testimony put in by the Turlock and Modesto irrigation districts as to their rights in the Tuolumne River, and also the protestations of a group of men scattered from the Pacific to the Atlantic that to "dam Hetch Hetchy" would be one of the greatest desecrations of natural beauty ever perpetrated. Fortunately he has able engineering aids in the Board of Advisory Engineers (of the U. S. Army) appointed for that purpose. He also has a reputation for keen judg-

ment and rare impartiality—which is the only point of agreement among the four parties engaged in the Hetch Hetchy controversy.

PUBLICATIONS RECEIVED

AMERICAN MINE ACCOUNTING—Methods and Forms Employed by Leading Mining Companies. By W. H. Charlton, P. A., Member, Lake Superior Mining Institute. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. viii + 367; 250 text figures. $5, net.

BIOGRAPHY OF GEORG VON REICHENBACH—By Walther von Dyck. München (Germany): Deutsches Museum. Stiff paper; 10x14½ in.; pp. 140; 75 illustrations and 8 plates.

A splendidly illustrated and printed biography of Georg von Reichenbach, the early engineer, scientist and instrument maker. It is based on original material in the new Deutsche Museum; the author appears to have spared no pains to present his subject adequately.

THE "BUILDING AGE" HANDY ESTIMATE BLANKS—Compiled by Arthur W. Joslin, author of "Estimating the Cost of Building." New York: David Williams Co. Paper; 7½x10 in. Single copies, 25c.; per dozen, $2.50.

Tabular forms for making up estimates of the cost of buildings.

DESIGN OF POLYPHASE GENERATORS AND MOTORS—By Henry M. Hobart, M. Inst. C. E., Consulting Engineer, General Electric Co. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. viii + 265; 125 text figures. $3, net.

ECONOMICAL IRRIGATION BY PUMPING—Bulletin 127 of the American Well Works, Aurora, Ill. Paper; 7½x10¾ in.; pp. 72; illustrated.

Primarily a trade catalog, this pamphlet contains various tabular and other data of possible use to engineers and irrigators.

THE ELEMENTS OF HEATING AND VENTILATION—A Textbook for Students, Engineers and Architects. By Arthur M. Greene, Jr., Professor of Mechanical Engineering, Russell Sage Foundation, Rensselaer Polytechnic Institute; Some time Junior Dean, School of Engineering, University of Missouri. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. vi + 324; 223 text illustrations. $2.50.

THE ELEMENTS OF MACHINE DESIGN—Part II, Chiefly on Engine Details. By W. Cawthorne Unwin, F. R. S., L. L. D., Formerly Professor of Engineering at the Central echnical College, and Professor of Hydraulic and Mechanical Engineering at the Royal Indian Engineering College, and A. L. Mellanby, D. Sc., Professor of Engineering at the Royal Technical College, Glasgow. New and revised edition. New York, Bombay and Calcutta: Longmans, Green & Co. Cloth: 5½x9 in.; pp. xxiii + 422; 317 illustrations in text. $2.50.

ELEVATOR SHAFT CONSTRUCTION or Practical Suggestions for the Installation of Electric Elevators in Buildings—By H. Robert Cullmer, Assisted by Albert Bauer. With Introductory Note by Reginald Pelham Bolton. New York: The William T. Comstock Co. Cloth; 6½x10 in.; pp. 174; 63 plates; $3.

This is a book for the architect. It discusses and gives data on the layout of elevator shafts as to dimensions and clearances, and treats of shaft doors and elevator signal systems. A form of specification for elevators and elevator equipment is given, and the New York regulations for elevators are reprinted.

EXPERIMENTAL WIRELESS STATIONS, Their Theory, Design, Construction and Operation—A complete account of sharply tuned modern wireless installations for experimental purposes, which comply with the new wireless law. By Philip E. Edelman, author of "Inventions and Patents," "Simple Experiments in Chemistry," "An Experimental Quenched Arc System," "How to Comply with the New Wireless Law." Minneapolis, Minn.: Published by the author, at 2432 Lyndale Ave. South. Cloth; 5¼x8 in.; pp. 220; 80 illustrations. $2.

EXPERMENTS UPON THE DISINFECTION OF SEWAGE AND THE EFFLUENTS FROM SEWAGE FILTERS—By H. W. Clark and Stephen DeM. Gage. [Reprinted from the Forty-third Annual Report of the Massachusetts State Board of Health]. Boston: The Board. Paper; 5½x9 in.; pp. 28.

HEIZUNGS-, LUFTUNGS- UND DAMPFKRAFTANLAGEN in den Vereinigten Staaten von Amerika—By Arthur K. Ohmes, Consulting Engineer. München und Berlin: R. Oldenbourg. Cloth; 6½x9¾ in.; pp. vii + 182; 119 text illustrations and 8 tables. 6 marks.

Consists of revised and extended reprints of articles published in "Gesundheit-Ingenieur" during the past few years, describing the heating and ventilating plants designed by the late Alfred R. Wolff for a number of important buildings in the United States, mostly in New York City. Included in the list of buildings are the Hotel St. Regis, the New Theater, the Metropolitan Art Museum and the United Engineering Societies Building, New York City; the store of Gimbel Brothers, Philadelphia, and the State Capitol at Hartford, Conn.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES FOR BUYERS AND SELLERS, Especially Devoted to the Interests of the Architectural, Mechanical, Engineering, Contracting, Electrical, Railroad, Iron, Steel, Hardware, Mining, Mill, Quarrying, Exporting and Kindred Industries. Twenty-first Annual Edition. New York: Samuel E. Hendricks Co., 74 Lafayette St. Cloth; 7½x10½ in.; pp. 1574. $10.

HILFSTABELLEN ZUE BERECHNUNG VON WARMWASSERHEIZUNGEN—By H. Recknagel, Diplom-Ingenieur. München and Berlin: R. Oldenbourg. Stiff paper; 9½x13½ in.; pp. 28; 4.50 marks.

Gives tables of heat radiation per square foot for various water and room temperatures and various kinds of radiation surface, pipe capacity in heat and water units, and similar tables for hot-water heating computations.

INDEX TO THE STRATIGRAPHY OF NORTH AMERICA—By Bailey Willis. Professional Paper 71, U. S. Geological Survey, Washington, D. C. Paper; 9x11½ in.; pp. 894; 19 text illustrations and one geologic map of North America, in separate portfolio.

IRON AND STEEL CONSTRUCTIONAL WORK—A Concise Handbook with Examples for Practical Application. Vol. III, The Broadway Series of Engineering Handbooks. By Karl Schindler. Translated from the German and adapted to English Practice by Chas. Salter. New York: D. Van Nostrand Co. London: Scott, Greenwood & Son. Cloth; 4½x7½ in.; pp. xii + 140; 115 text illustrations. $1.25, net.

The structural engineer concerned with framework of buildings will be interested in this book, as giving a German's view of steel structural work through English spectacles. The treatment is descriptive and elementary, not to say superficial. It is not likely to supply the American engineer with any direct working material or data, but may tend to broaden his way of handling routine structural problems.

IRRIGATION: ITS PRINCIPLES AND PRACTICE AS A BRANCH OF ENGINEERING—By Sir Hanbury Brown, K. C. M. G., M. Inst. C. E. Second edition, revised. New York: D. Van Nostrand Co. Cloth; 5¾x9¼ in.; pp. xv + 301; 68 text figures and several plates. $5, net.

ISOSTASY, A REJOINDER TO THE ARTICLE BY HARMON LEWIS—By John F. Hayford. Reprinted for private circulation from the "Journal of Geology," Vol. XX, No. 6, September-October, 1912. Paper; 6¾x9¾ in.; pp. 17.

KARSTGEBIETE UND IHRE WASSERKRAEFTE—Eine Studie aus Oeffentlichen Vorträgen des Verfassers über die Ausnützung und Verwertung der Wasserkräfte in den Karstländern der Ost.-Ung. Monarchie. By Theodor Schenkel, Behördlich Autorisierter Zivil-Ingenieur U. St. Beeid. Sachverständiger. Wien and Leipzig: A. Hartleben. Cloth; 7x10½ in.; pp. 91; 125 illustrations. Marks 8; American price, $3.20, net.

The power possibilities of certain streams in southeastern Austria are discussed. The region abounds in caves and fissures, the course of the streams is broken by underground portions, and the distribution of surface flow through the year has irregularities markedly different from those of normal streams.

METHODS FOR THE ANALYSIS OF IRON AND STEEL, USED IN LABORATORIES OF THE AMERICAN ROLLING MILL CO., MIDDLETOWN, OHIO—Middletown, Ohio: The American Rolling Mill Co., Research Department. Cloth; 6x9½ in.; pp. 62; illustrated. [We understand that a limited number of copies of this book are available, to those particularly interested.—Ed.].

METHODS OF MEASURING ELECTRICAL RESISTANCE—Edwin F. Northrup, Ph. D., M. A. I. E. E. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. xiii + 389; 1505 text illustrations. $4, net.

MODERN SANITARY ENGINEERING. Part I, House Drainage—By Gilbert Thomson, M. A., F. R. S. E., M. Inst. C. E., Lecturer on Sanitary Engineering in the Royal Technical College, Glasgow. New York: D. Van Nostrand Co. Cloth; 5½x8¾ in.; pp. xv + 266; 110 text illustrations. $3, net.

MUNICIPAL WATER SUPPLIES OF COLORADO—By Clement C. Williams, C. E., Assistant Professor of Civil Engineering. Bulletin of the University of Colorado, Vol. XII. No. 5. Boulder, Colo.: The University. Paper; 6x9 in.; pp. 56; illustrated.

The essential features of a public water-supply are stated and the various elements of water-works are given. Then follow descriptions of the water-works of Colorado municipalities of 500 population and upward and a table of the rates charged in 49 cities.

THE NEW BUILDING ESTIMATOR—A Practical Guide to Estimating the Cost of Labor and Material in Building Construction, from Excavation to Finish; with Various Practical Examples of Work Presented in Detail and with Labor Figured Chiefly in Hours and Quantities. A Handbook for Architects, Builders, Contractors, Appraisers, Engineers, Superintendents and Draftsmen—By William Arthur. Eleventh edition, revised and enlarged. New York: David Williams Co. Flexible leather; 4½x7 in.; pp. 713; illustrated. $3, postpaid.

PRACTICAL MATHEMATICS, Being the Essentials of Arithmetic, Geometry, Algebra and Trigonometry. Part III, Algebra with Applications—By Claude Irwin Palmer, Assistant Professor of Mathematics, Armour Institute of Technology. New York and London: McGraw-Hill Book Co. Cloth; 4½x7¼ in.; pp. xi + 178; 31 text figures. 75c., net.

PROBLEMS IN ENGINEERING WITH SOLUTIONS—Being Questions and Answers Reprinted from the Assistants' and Students' Section of the "Surveyor and Municipal and County Engineer." First series. Edited by Sydney G. Turner, Assoc. M. Inst. C. E. London: St. Bride's Press, Ltd. Cloth; 5x7½ in.; pp. 186; numerous illustrations. $2, net (5/-, net).

A collection of many kinds of problems, and answers to them, apparently from the "Question and Answers" columns of a technical paper. Though grouped to an approximate subject classification, the problems will not be found to cover with any pretense at completeness the subjects indicated by the group headings. However, many readers may find themselves helped over one or another doubt by studying this book as an auxiliary to their textbooks. But many